AD-A053 827 ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND REDSTO--ETC F/G 20/5
COMPILATION OF DATA RELEVANT TO RARE GAS-RARE GAS AND RARE GAS---ETC(U)
DEC 77 E W MCDANIEL, M R FLANNERY, H W ELLIS
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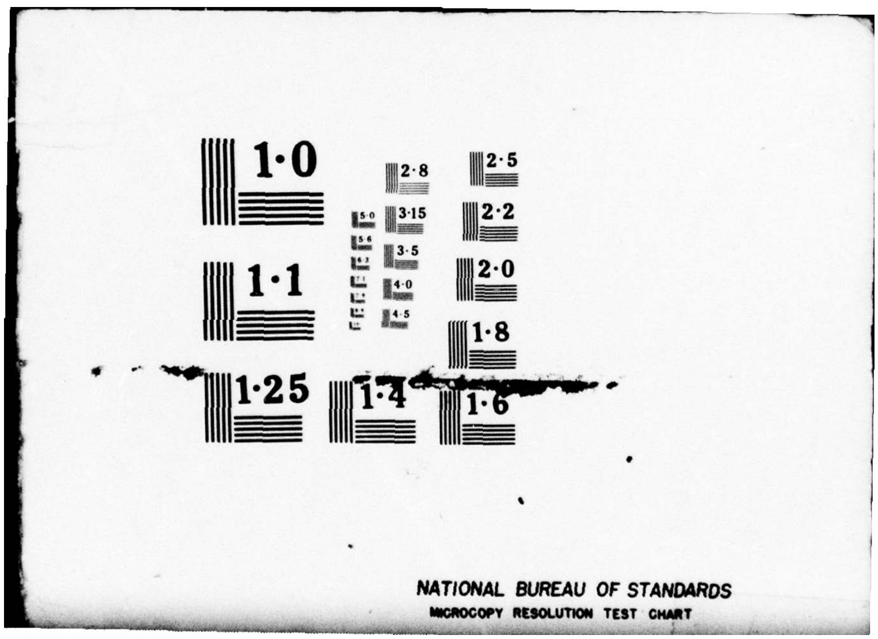
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TECHNICAL REPORT H-78-1

COMPILATION OF DATA RELEVANT TO RARE GAS-RARE GAS AND RARE GAS-MONOHALIDE EXCIMER LASERS

VOLUME I

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U.S. ARMY
MISSILE
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December 1977

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PREPARED FOR:
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DMI FORM 1000, 1 APR 77

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
H-78-1

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
6 COMPILATION OF DATA RELEVANT TO RARE GAS-RARE GAS AND RARE GAS-MONOHALIDE EXCIMER LASERS. VOLUME I

5. TYPE OF REPORT & PERIOD COVERED
9 Technical [redacted] rept.,

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
10 E. W. McDaniel, M. R. Flannery, H. W. Ellis, F. L. Eisele, W. Pope and T. G. Roberts

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Commander
US Army Missile Research and Development Command
Attn: DRDMI-H
Redstone Arsenal, Alabama 35809

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Commander
US Army Missile Research and Development Command
Attn: DRDMI-TI
Redstone Arsenal, Alabama 35809

12. REPORT DATE
11 Dece[redacted] 1977

13. NUMBER OF PAGES
427 * 12 421p.

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
14 DRDMI-H-78-1-VOL-1

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

* Volume I contains pages 1 through 427;
Volume II contains pages 429 through 894.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Lasers, Rare Gas-Rare Gas Excimers, Rare Gas-Monohalide Excimers, Cross Sections, Lifetimes, Reaction Rates, Transport Properties, Particle Collisions, and Potential Energy Curves

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a compilation of atomic data designed mainly to serve the needs of those engaged in research and development in the field of rare gas-halide and rare gas-rare gas excimer lasers. The bulk of the data relates to structural, radiative, and collisional properties of rare gas and halogen atoms and of the ions and molecules that can be formed from them. Two- and three-body collisions involving only heavy particles are covered, as are collisions of electrons and photons with the heavy particles.

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PREFACE

This report is a compilation of atomic data designed mainly to serve the needs of those engaged in research and development in the field of rare gas-halide and rare gas-rare gas excimer lasers. The bulk of the data relates to structural, radiative, and collisional properties of rare gas and halogen atoms, and of the ions and molecules that can be formed from them. Two- and three-body collisions involving only heavy particles are covered, as are collisions of electrons and photons with the heavy particles. Transport data on electrons, ions, and neutrals are included, and the interaction of heavy particles with electric and magnetic fields is considered. The impact of heavy particles, electrons, and photons with surfaces is also included, although such collisions appear not to have been included in excimer laser models to date.

A wealth of good data is at hand on structural and radiative properties of rare gas atoms and on most kinds of collisions involving these atoms in the ground state, and much useful information has recently become available on the structural properties of homonuclear and heteronuclear rare gas molecules. Comparatively little is known about collisions of various kinds of particles with rare gas atoms in excited and ionized states and with rare gas molecules. There is a dearth of data of almost every type on halogen atoms, molecules, and ions, and this fact has prompted us to take two steps. First, we included a few halogen data of old vintage because no newer data were available. Any halogen data (other than of spectroscopic origin) collected before about the mid-1960's should probably be regarded with reserve. Atomic collisions experiments on the halogen have been notoriously difficult until quite recent times, and even now they pose problems. We hope that this report will dramatize the lack of collisional data on the halogens and the rare gas-halide molecules and show where additional research needs to be done. The second step referred to above was to include collisional data on structures outside our area of responsibility if such data were thought to be useful. This step was taken mainly when no data were on hand for the halogen atoms, molecules, or ions. In certain cases, the data presented can be scaled by sound theoretical methods to provide information about the collision partners of interest. In the remaining cases, the user of this document might prefer to use a cross section or reaction rate for an extraneous system rather than rely totally on guesswork if no data are available on the system he is really interested in. A monitory "caveat emptor" may be in order here (if indeed, not a "cave canem").

We began this compilation with only electron beam- and electrical discharge-pumped lasers in mind. Electron collisions at all energies u up to about 10 Mev were included, but heavy particle-heavy particle collisions at energies up to only about 10 eV, this being the highest energy that we could conceive for heavy particles produced in dissociative events or for ions at the values of E/N (or E/p) existing in the lasers. However, we began to notice a few papers describing research

on excimer lasers excited by beams of fast heavy particles, so we expanded our coverage in this direction.

Now for a word about references. At the beginning of many of the main and secondary sections, a list of "general references" appears. These references are mainly books and review articles of general interest. Those marked "D" on the left contain much useful data; those labeled "R" contain a large number of relevant references. Most of these references came from "Bibliography on Sources of Information on Pheneomona of Interest in Gas Laser Research and Development" by E. W. McDaniel, H. W. Ellis, F. L. Eisele, and M. G. Thackston; US Army Missile Command, Redstone Arsenal, Alabama; Technical Report RH-77-1, January 1977 (202 pages).

Many of the tables and graphs presented here were taken directly from "Atomic Data for Controlled Fusion Research", by C. F. Barnett, J. A. Ray, E. Ricci, I. Wilker, E. W. McDaniel, E. W. Thomas, and H. B. Gilbody; Controlled Fusion Atomic Data Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee (Feb., 1977), Reports ORNL 5206 and 5207 (680 pages). Such graphs can be identified by the notation ORNL - the corresponding tables appear facing the graphs. Other ORNL tables, not paired with graphs, are easily recognizable by the same distinctive format. We are extremely indebted to C. F. Barnett, Director of the Controlled Fusion Atomic Data Center at Oak Ridge, for permission to use his material. Barnett and Wilker also helped us considerably by sending us recent printouts of categorized references.

Our sincere thanks go to E. C. Beaty, John Rumble, and Jean W. Gallagher of the JILA Information Center at the University of Colorado, Boulder, Colo. and to L. J. Kieffer, former Director of the Information Center. They generously provided processed data in more useful form than the original and gave us permission to use any of their graphs and tables. Without the cooperation and assistance of the Oak Ridge and JILA Information Centers, we could not have prepared this document in the allotted time.

Also we are very grateful to T. H. Dunning, Jr., P. J. Hays, and W. R. Wadt, all of LASL (Los Alamos Scientific Laboratory), who have rendered invaluable assistance by providing us with their calculated potential energy curves and other structural properties of the rare-gas halides and rare-gas molecular-ions in advance of publication of their articles.

Others who have helped us considerably by providing data, graphs, and advice are: D.L. Albritton; B. Bederson; M. A. Biondi; C. Cason; R. Celotta; P. J. Chantry; L. Christophorou; J. S. Cohen; A. Mandl; R. W. Crompton; L. G. H. Huxley; D. Howgate; R. Johnsen; M. Krauss; M. Kurepa; W. L. Lineberger; D. C. Lorents; K. McCann; A. V. Phelps; R. Saxon; B. Schneider; R. F. Stebbings; E. W. Thomas; F. K. Truby; W. L. Williams; and S. F. Wong.

A. STRUCTURAL PROPERTIES OF RARE-GAS HALIDE MOLECULES, RARE-GAS EXCIMERS, RARE-GAS MOLECULAR IONS AND RARE-GAS ATOMS

CONTENTS
(VOLUME I)

B. HEAVY PARTICLE-HEAVY PARTICLE COLLISIONS

A. STRUCTURAL PROPERTIES OF RARE-GAS HALIDE MOLECULES, RARE-GAS EXCIMERS, RARE-GAS MOLECULAR IONS AND RARE-GAS ATOMS

General References: Rare-Gas Halides, Rare-Gas Excimers (Ions), Rare-Gas Excimers (Neutrals). Rare-Gas Halide Laser and Fluorescent Wavelengths (Table and References).

CONTENTS

A. STRUCTURAL PROPERTIES OF RARE-GAS HALIDE MOLECULES, RARE-GAS EXCIMERS, RARE-GAS MOLECULAR IONS, AND RARE-GAS ATOMS

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Table* A-1
Rare-Gas Halide Laser and Fluorescent Wavelengths

	Ne	Ar	Kr	Xe
F	Fluoresces 108 Dissociates (A)	Laser 193 (B)	Laser 248 (C)	Laser 351 (D)
Cl	Dissociates Cl_2 (254) (E)	Fluoresces 175 Dissociates (F)	Laser 222 (G)	Laser 308 (H)
Br	Dissociates Br_2 (290) (E)	Dissociates Br_2 (290) (I)	Fluoresces 206 (J)	Laser 282 (K)
I	Dissociates I_2 (342) (E)	Dissociates I_2 (342) (L)	Dissociates I_2 (342) (M)	Fluoresces 254 Dissociates (N)

The Wavelengths are in nm. In high density media the dominant emitters and their peak wavelength are listed.

*Taken from D. C. Lorents, "Kinetic processes in rare-gas halide lasers," Invited talk, X International Conference on the Physics of Electronic and Atomic Collisions, Paris, July 1977.

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A-1. CALCULATED POTENTIAL ENERGY CURVES FOR RARE GAS-HALIDES

CONTENTS

A-1. References:

The figures in (A-1.1) to (A-1.22) are taken from the following sources:

(A-1-1)-(A-1-8) and (A-1-22):

T. H. Dunning, Jr., and P. J. Hay, "The Low-Lying States of the Rare-Gas Fluorides," J. Chem. Phys. (to be published).

(A-1-9)-(A-1-14):

P. J. Hay and T. H. Dunning, Jr., "Electronic States of the Xenon Halides," J. Chem. Phys. (to be published).

(A-1-15)-(A-1-21):

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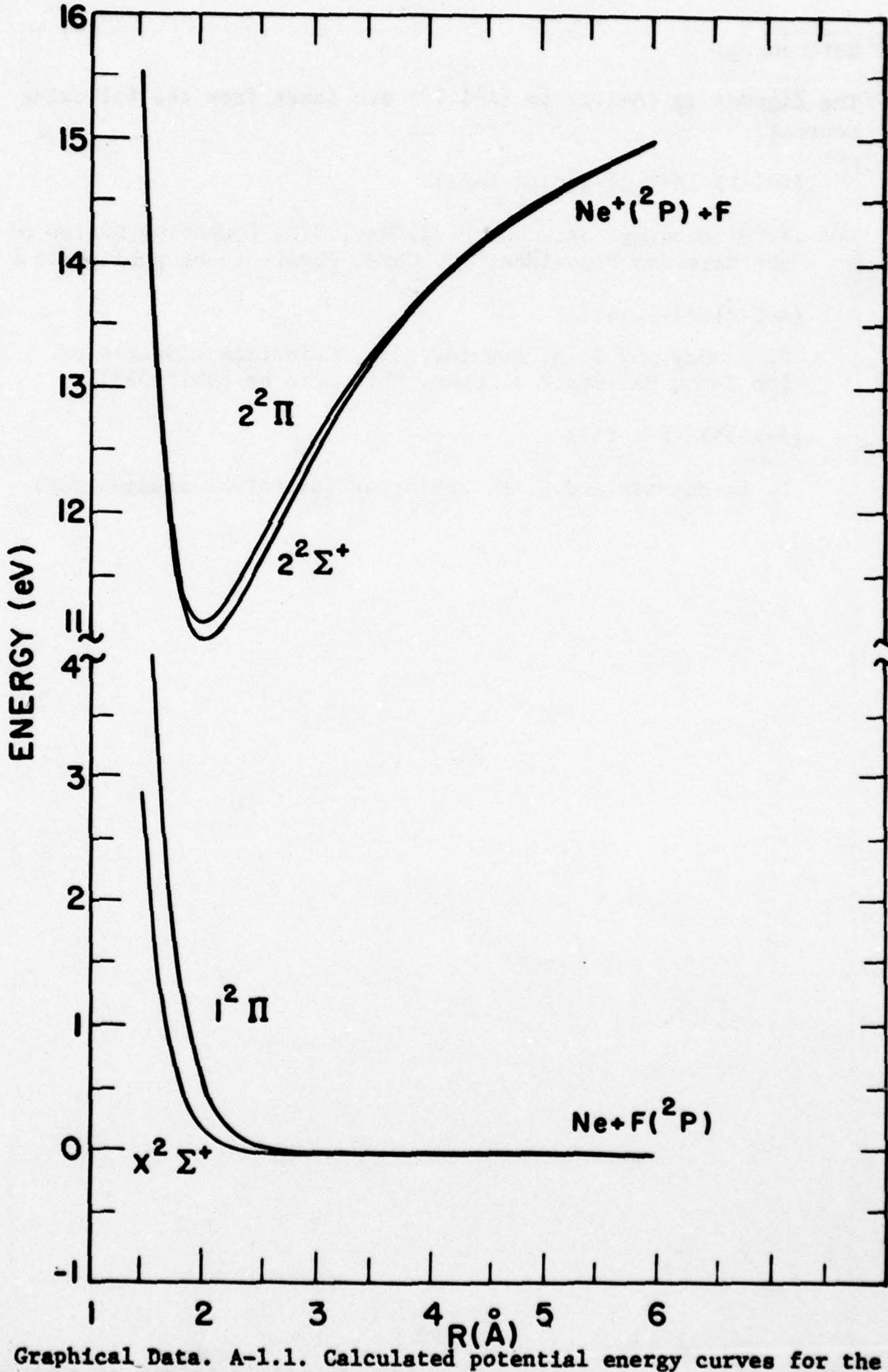
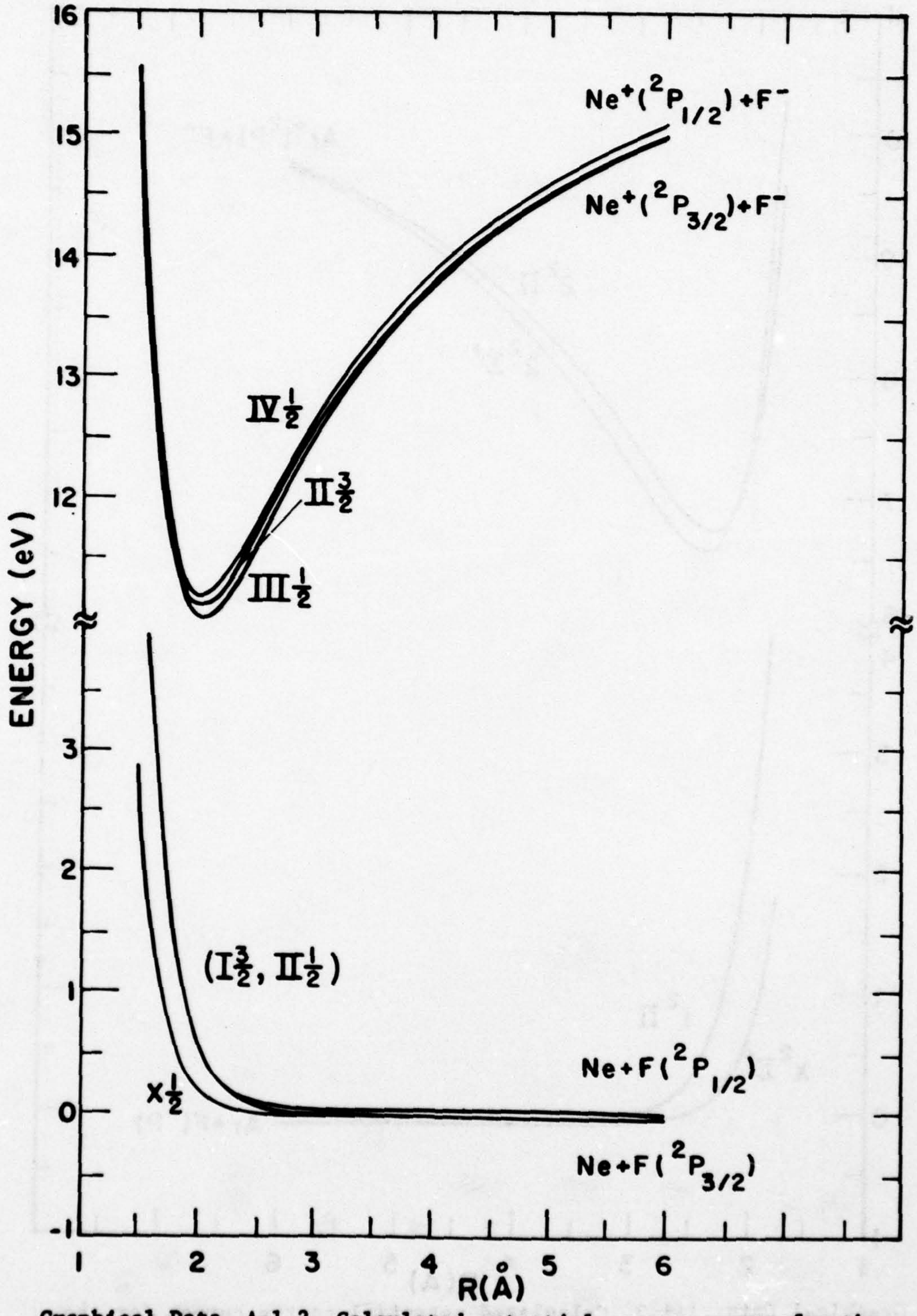
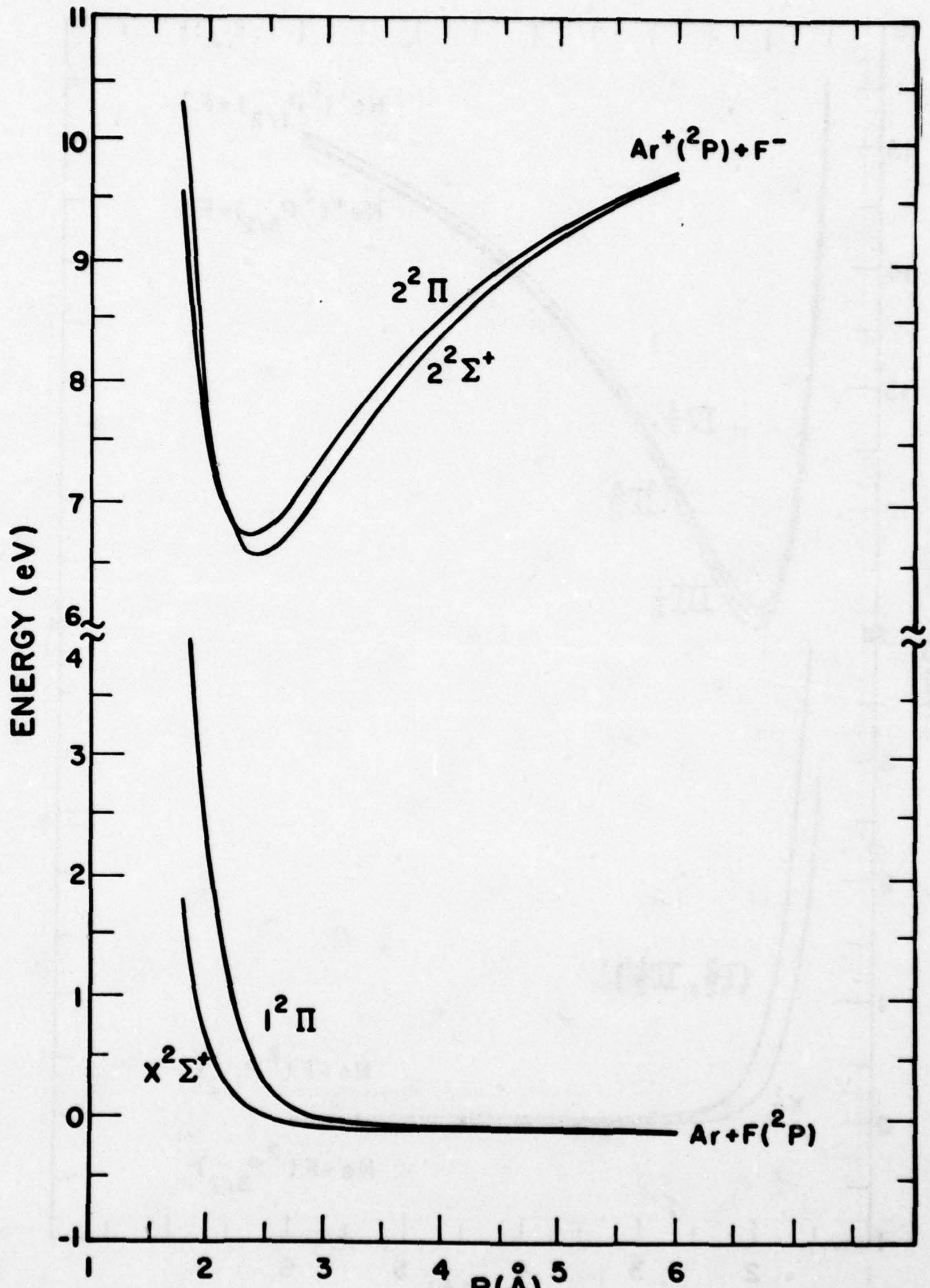


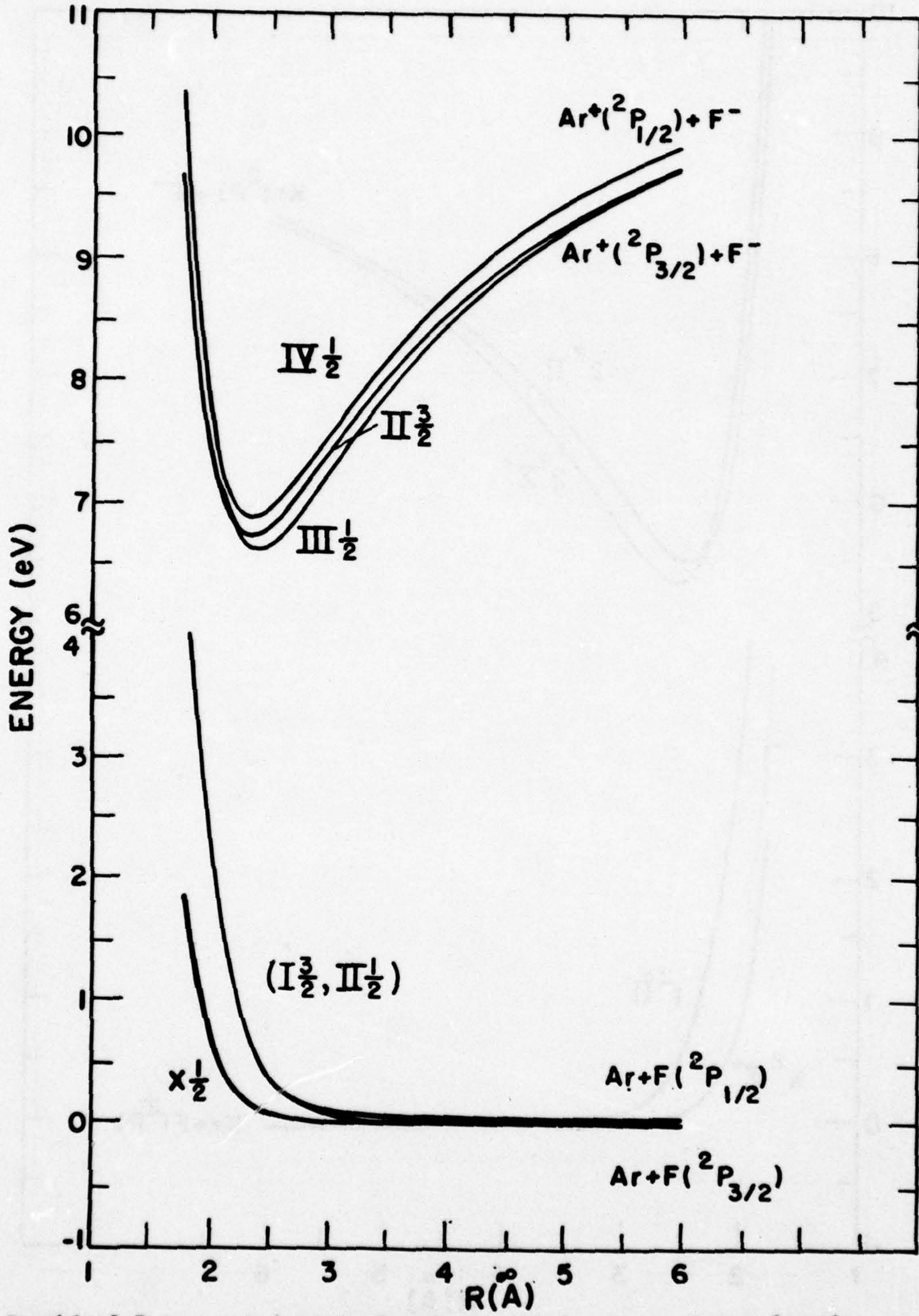
Graphical Data. A-1.1. Calculated potential energy curves for the covalent and ionic states of NeF.



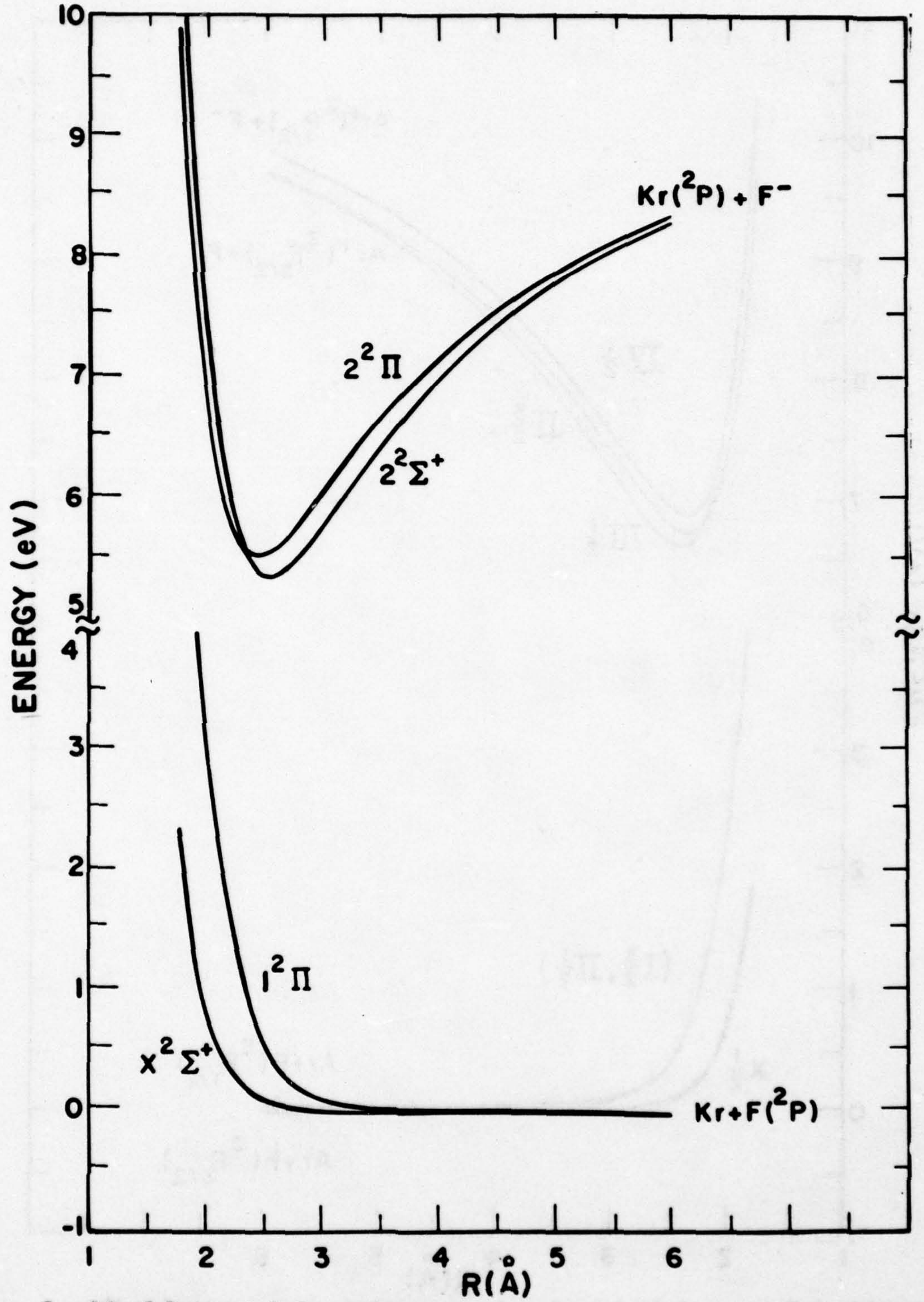
Graphical Data. A-1.2. Calculated potential energy curves for the covalent and ionic states of NeF, with spin-orbit corrections.



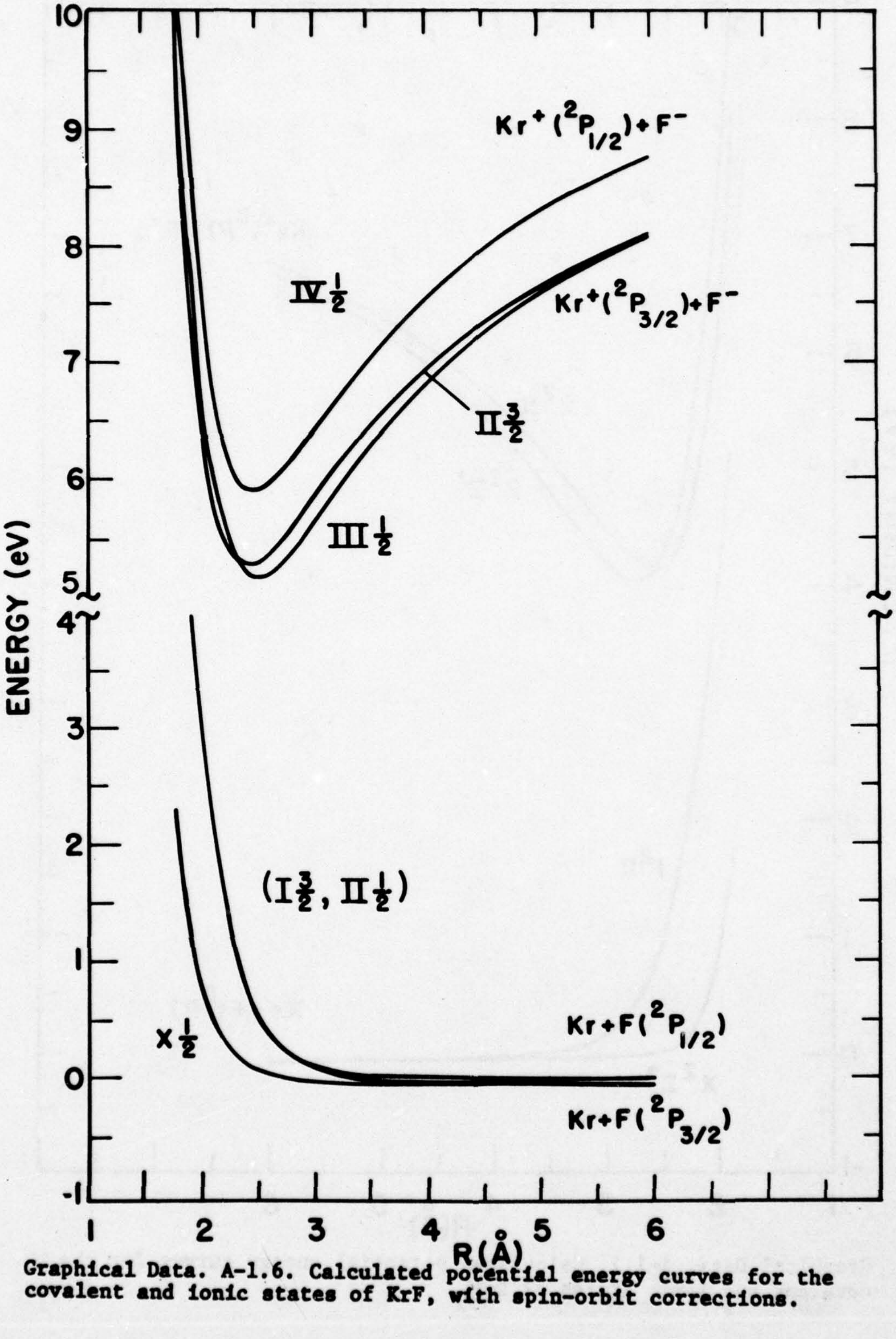
Graphical Data. A-1.3. Calculated potential energy curves for the covalent and ionic states of ArF.



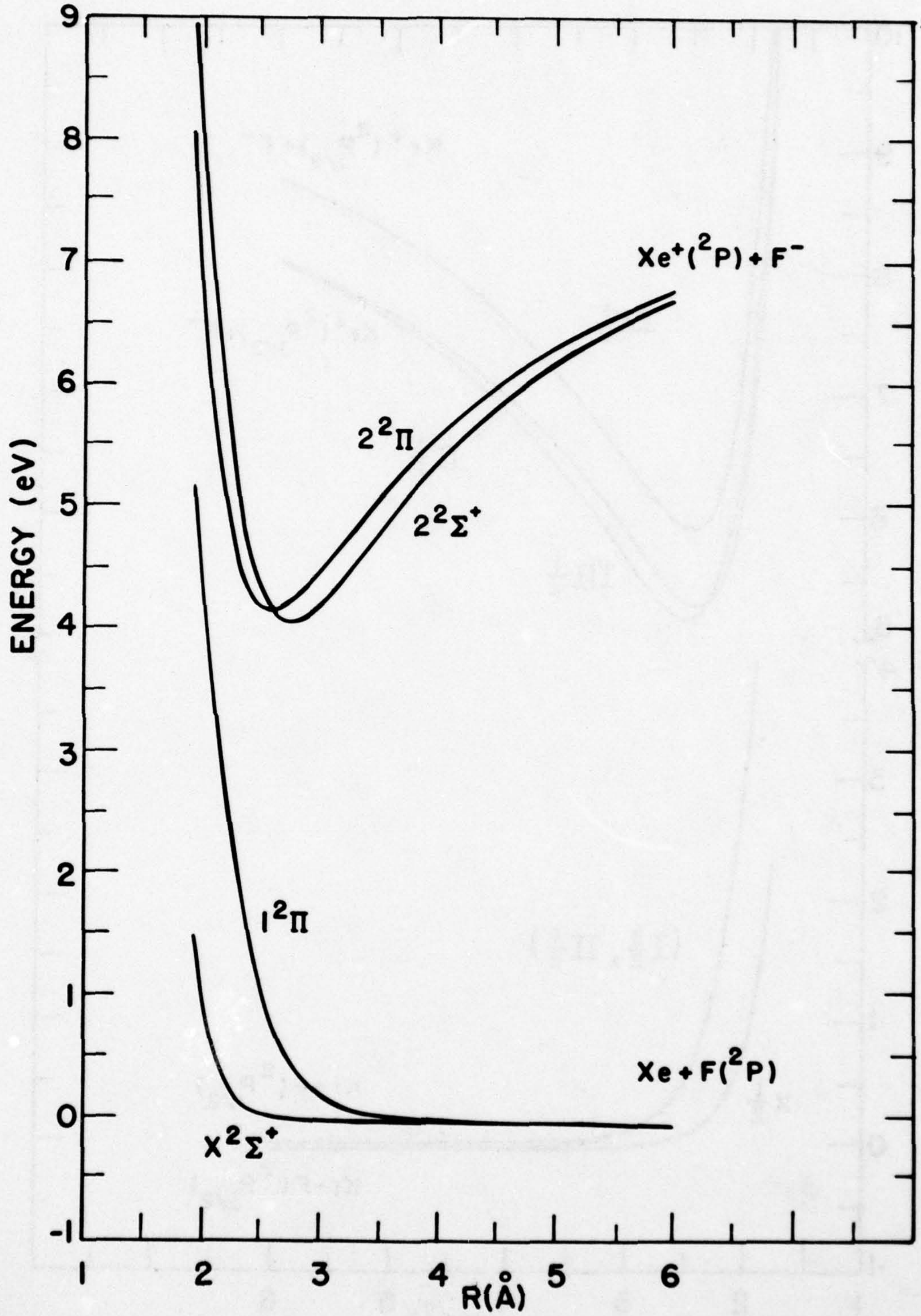
Graphical Data. A-1.4. Calculated potential energy curves for the covalent and ionic states of ArF, with spin-orbit corrections.



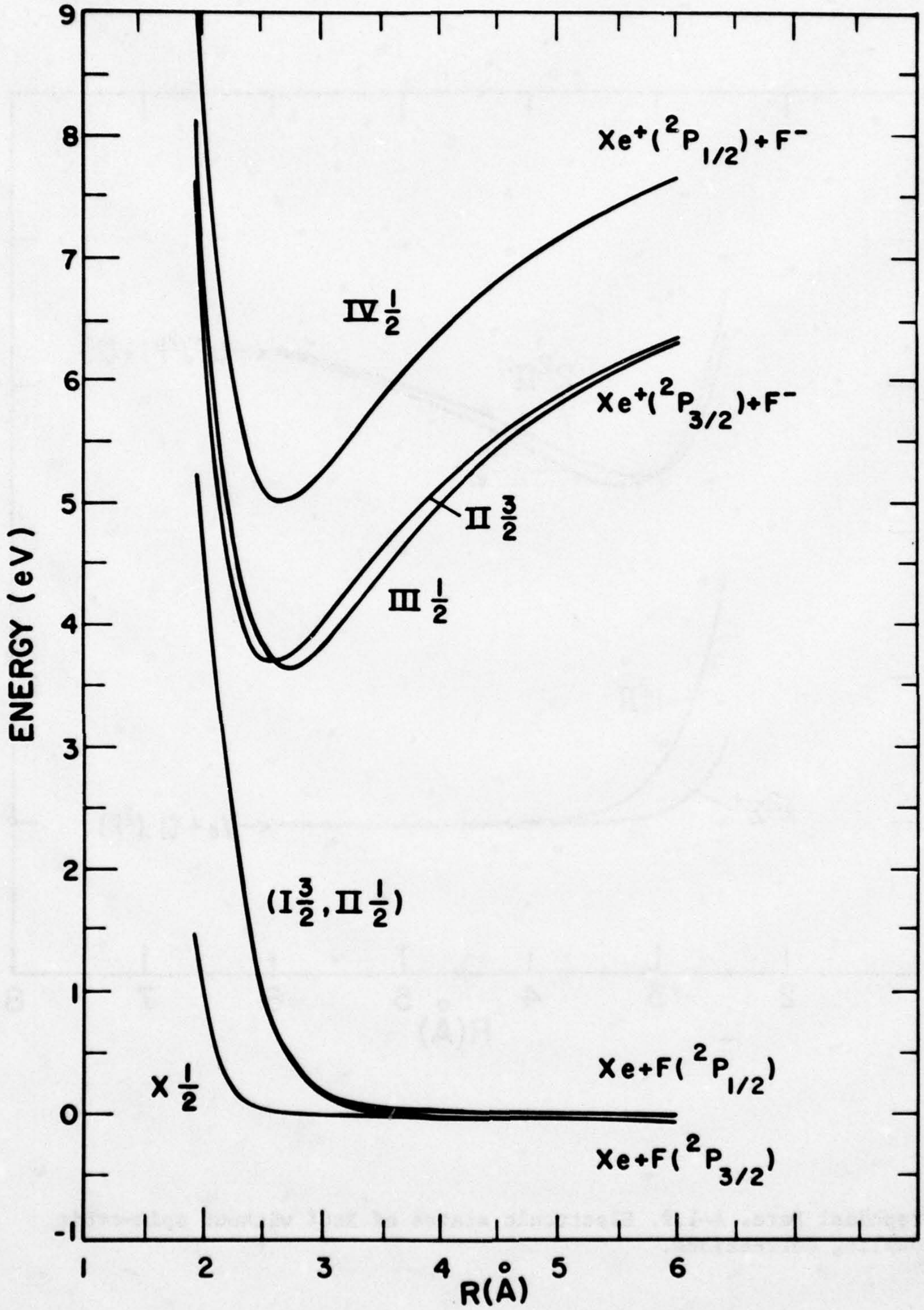
Graphical Data. A-1.5. Calculated potential energy curves for the covalent and ionic states of KrF.



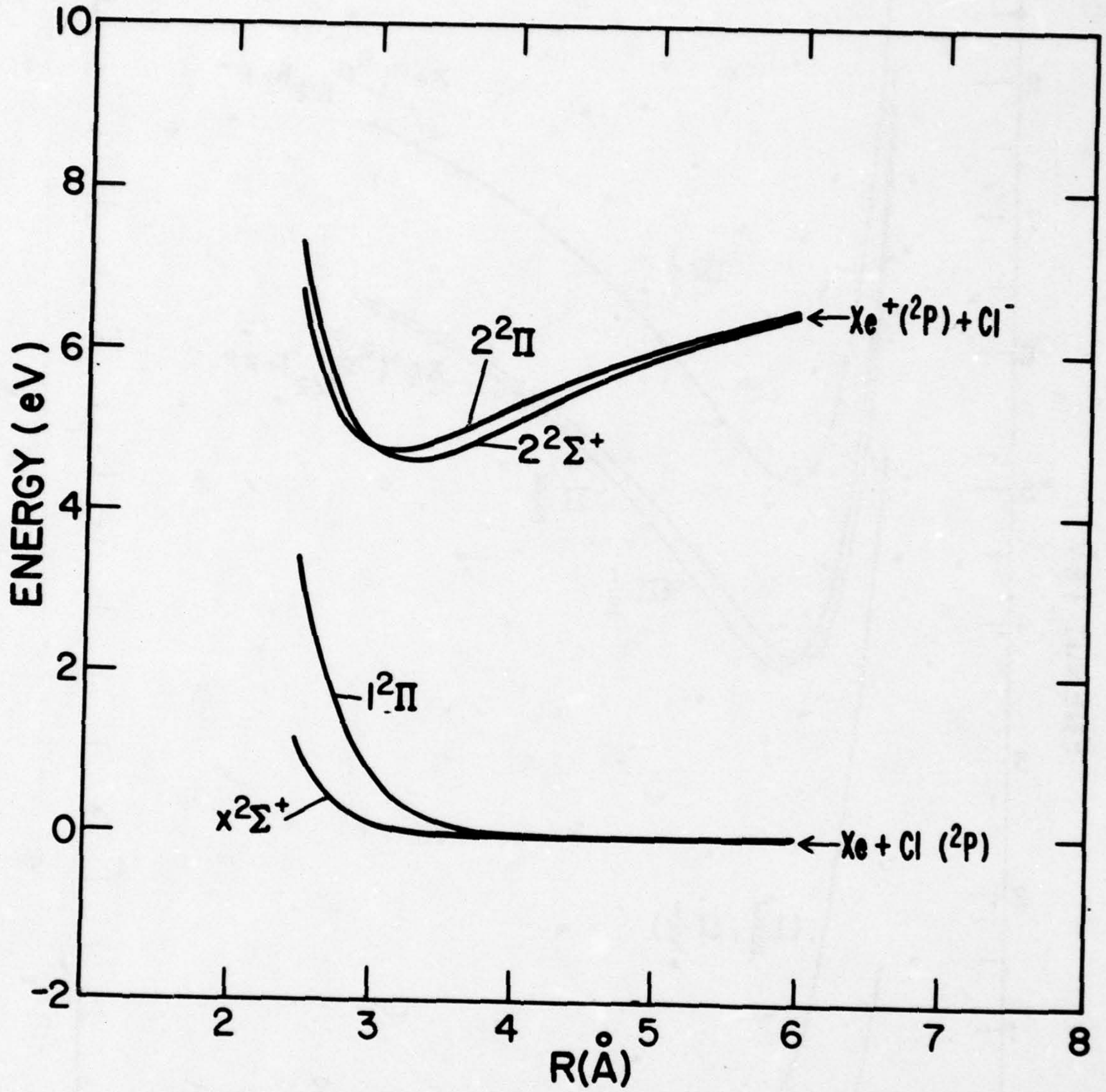
Graphical Data. A-1.6. Calculated potential energy curves for the covalent and ionic states of KrF, with spin-orbit corrections.



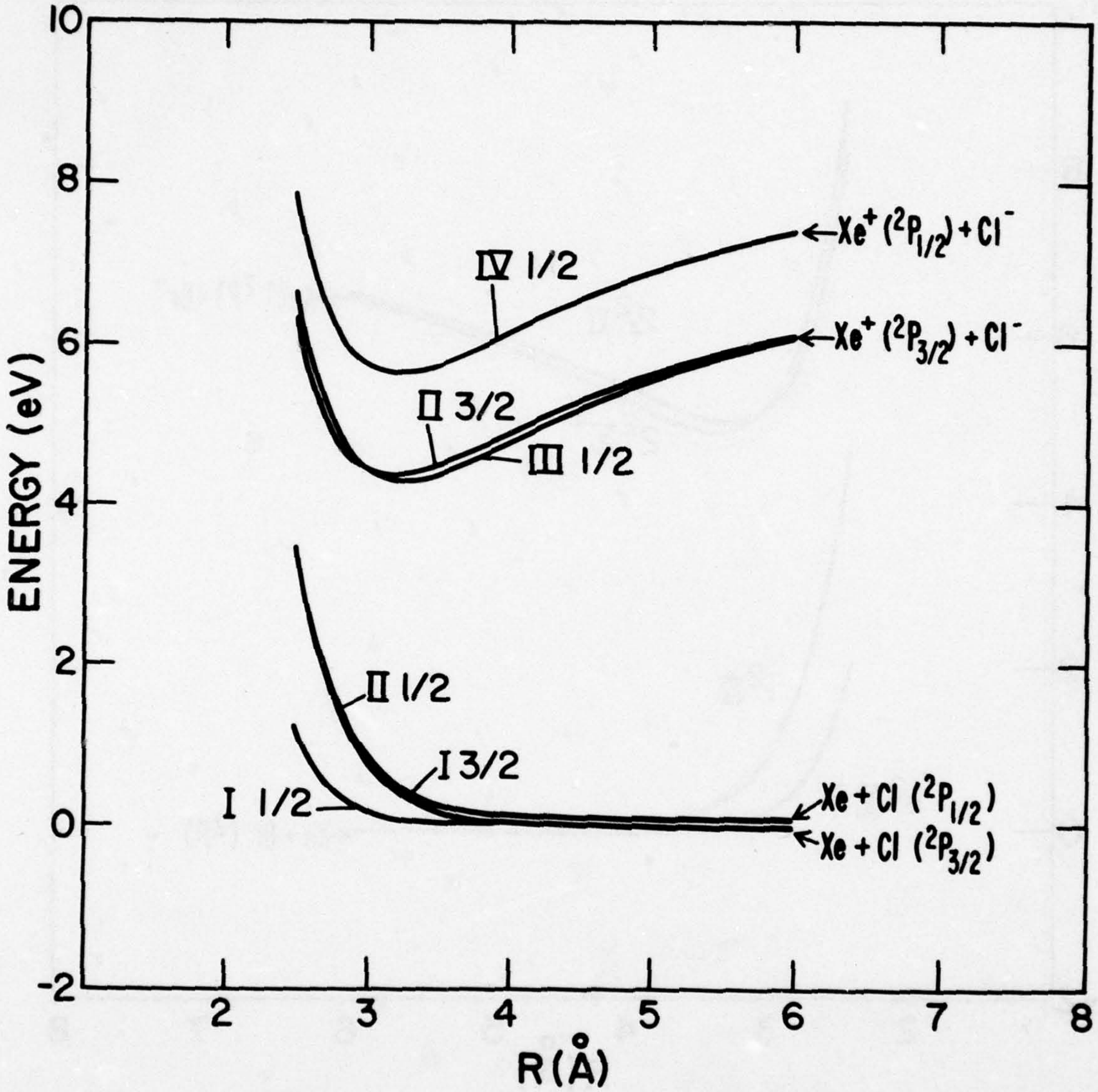
Graphical Data. A-1.7. Calculated potential energy curves for the covalent and ionic states of XeF.



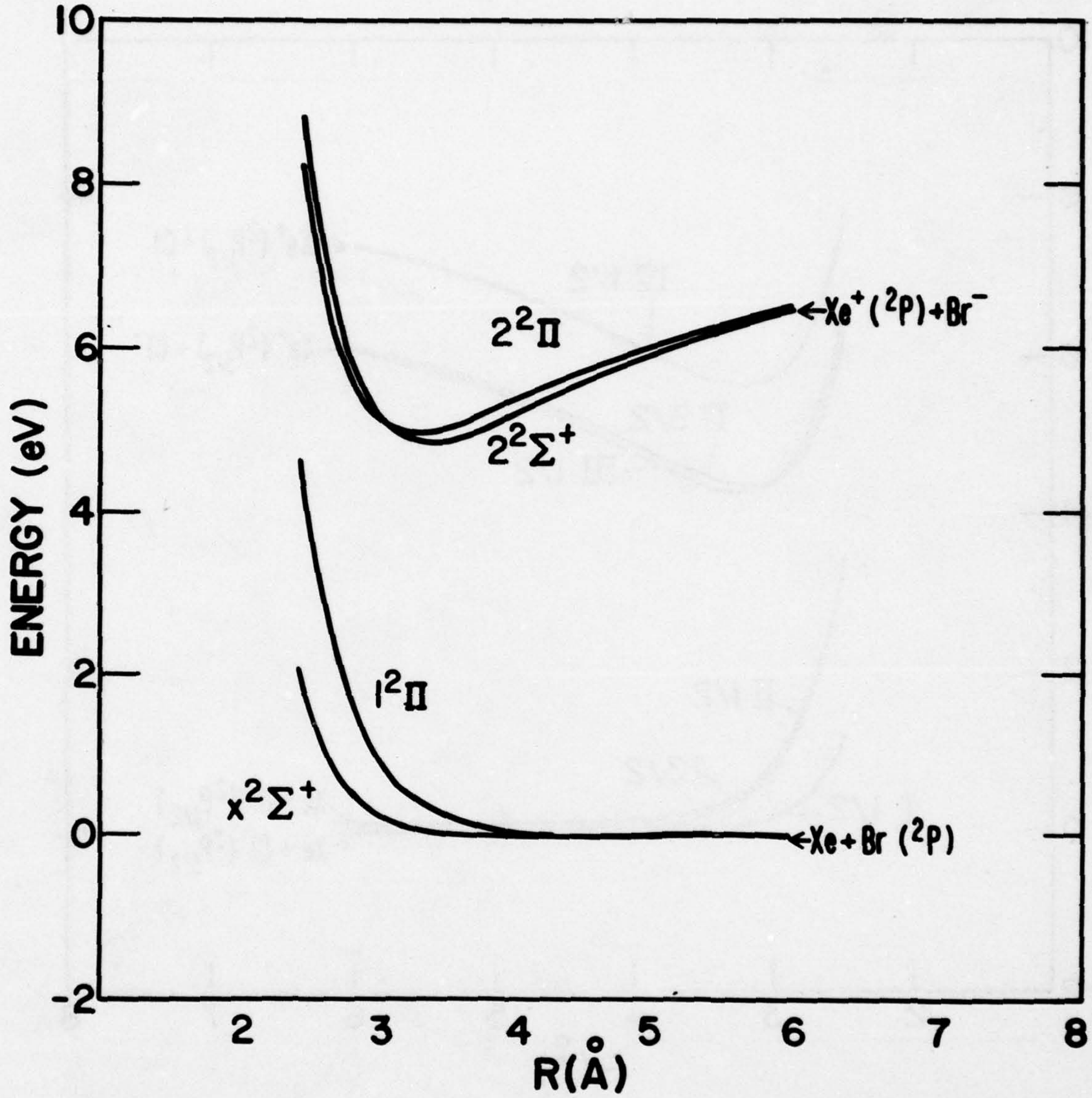
Graphical Data. A-1.8. Calculated potential energy for the covalent and ionic states of XeF, with spin-orbit corrections.



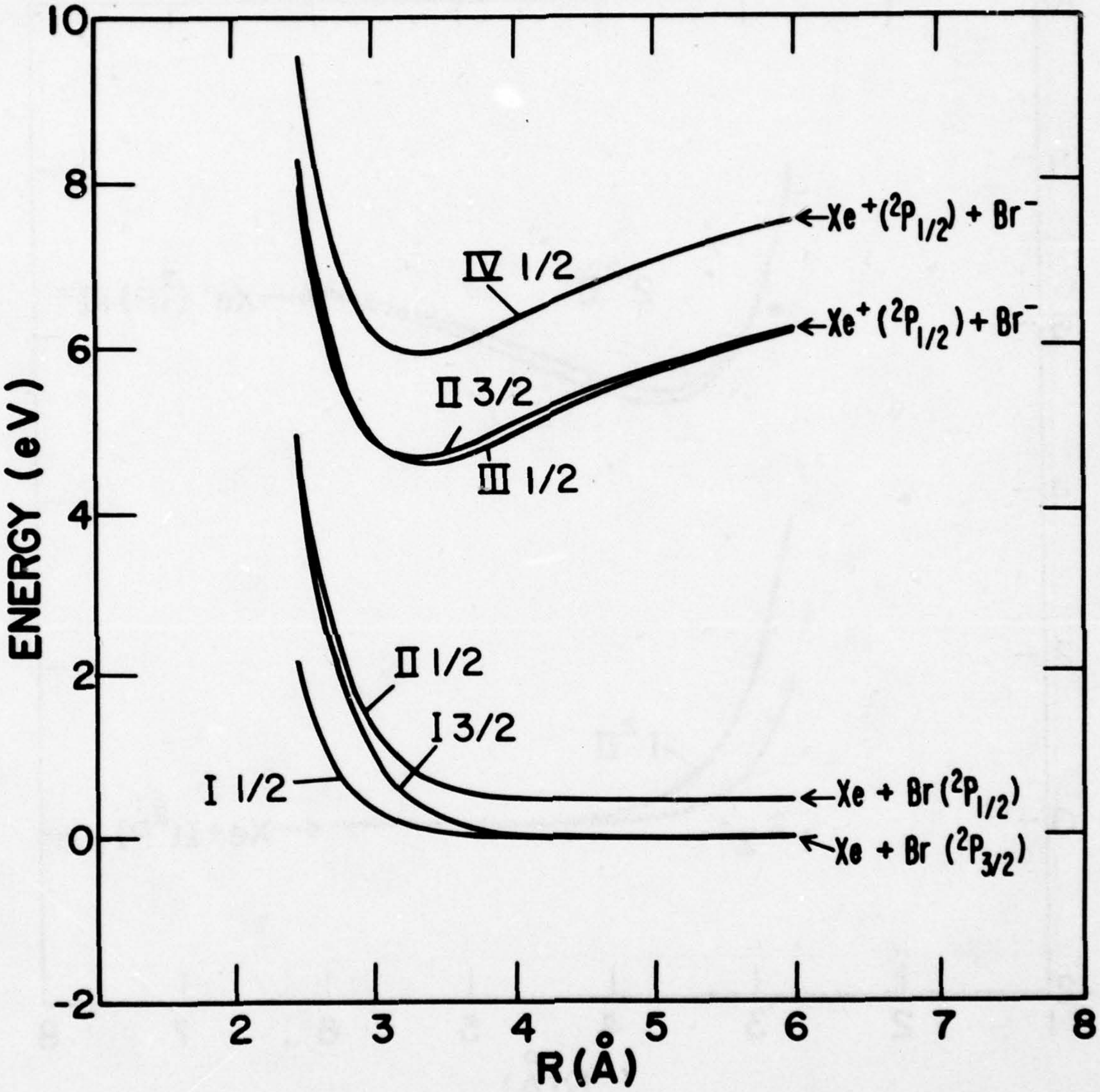
Graphical Data. A-1.9. Electronic states of XeCℓ without spin-orbit coupling corrections.



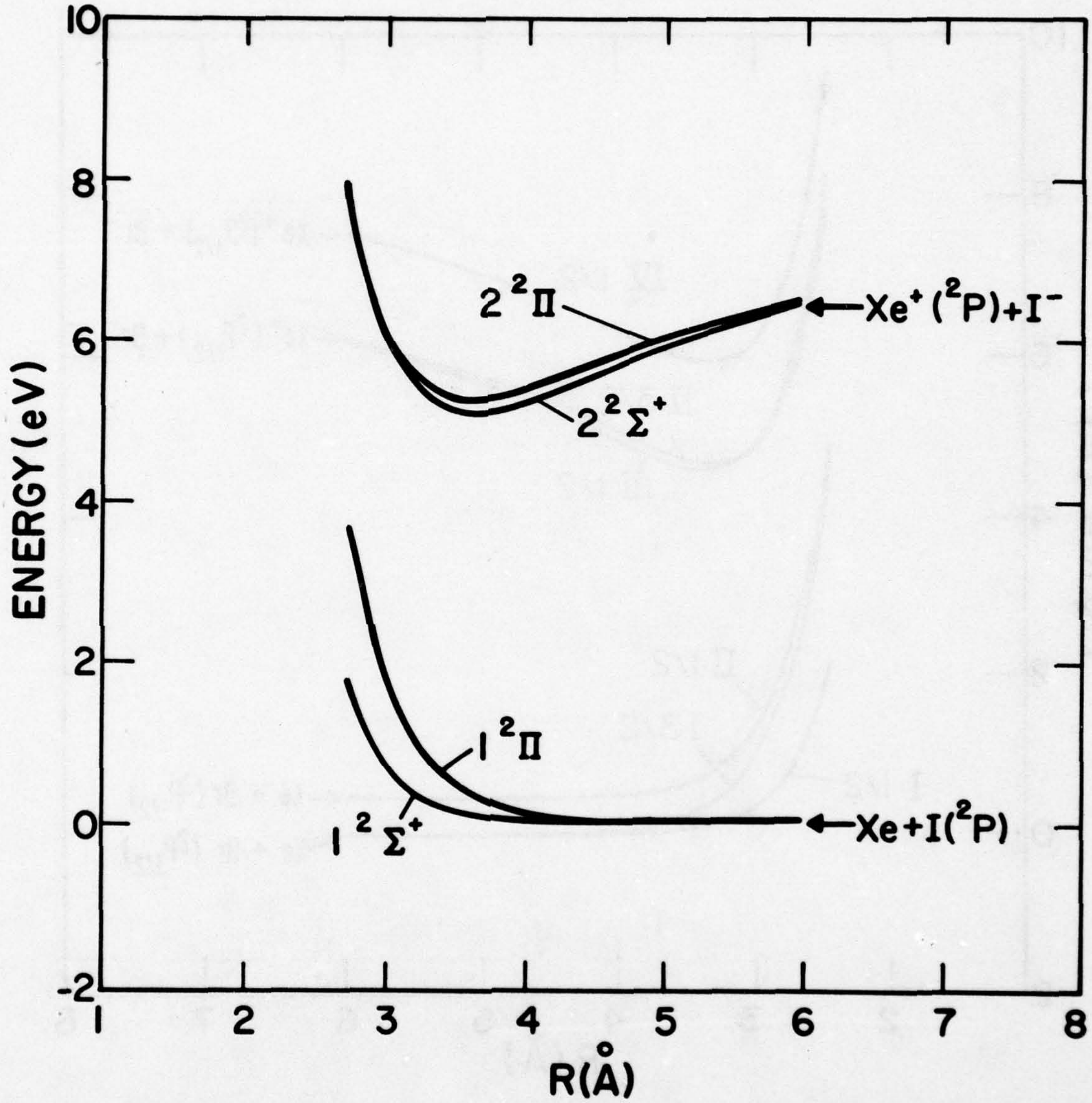
Graphical Data. A-1.10. Electronic states of XeCℓ including spin-orbit coupling.



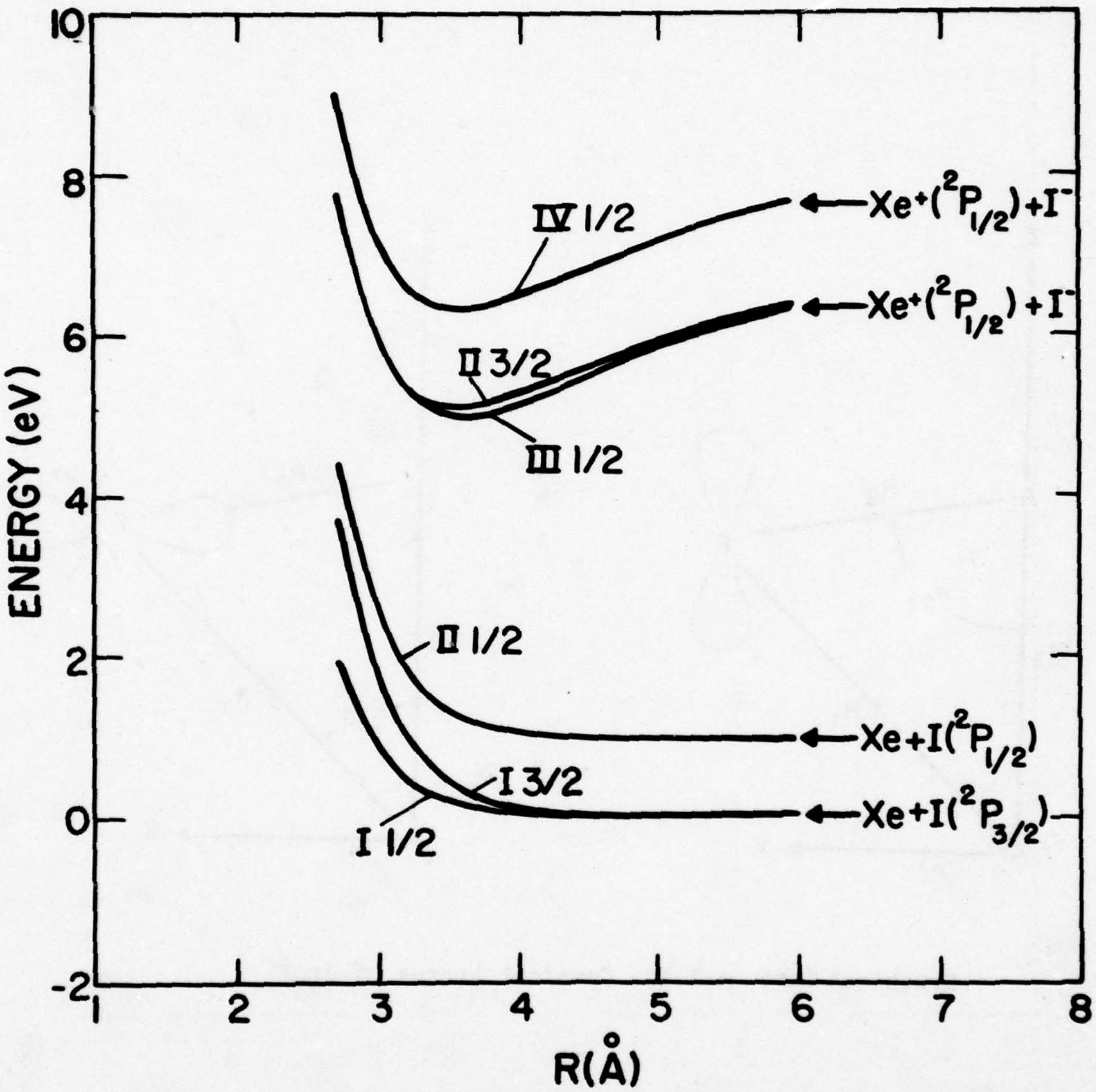
Graphical Data A-1.11. Electronic states of XeBr without spin-orbit coupling corrections.



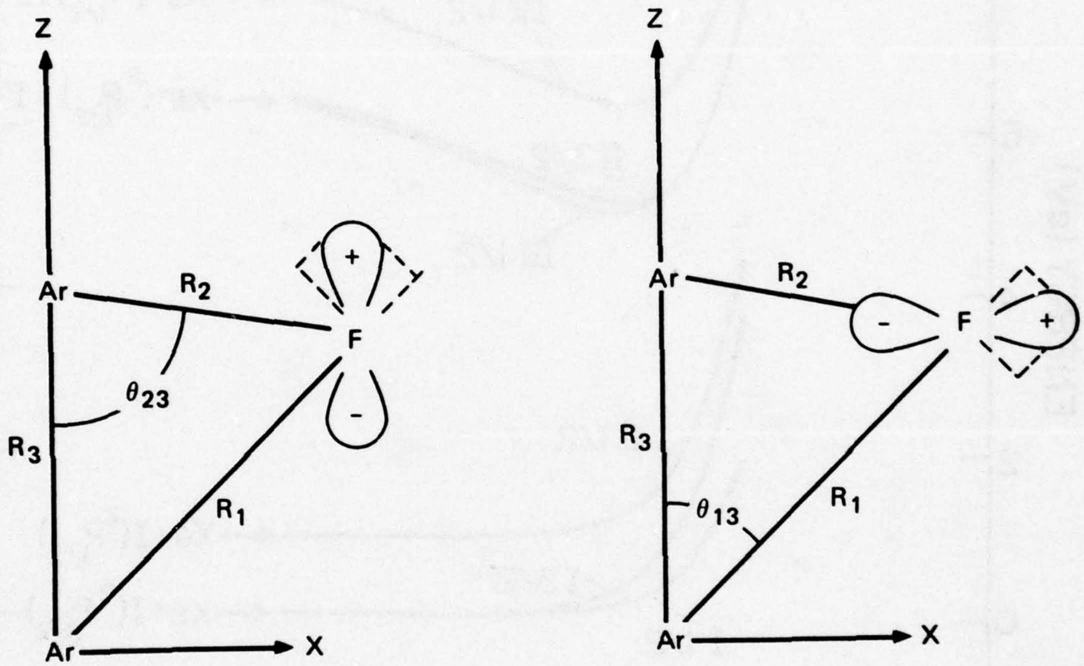
Graphical Data. A-1.12. Electronic states of XeBr including spin-orbit coupling.



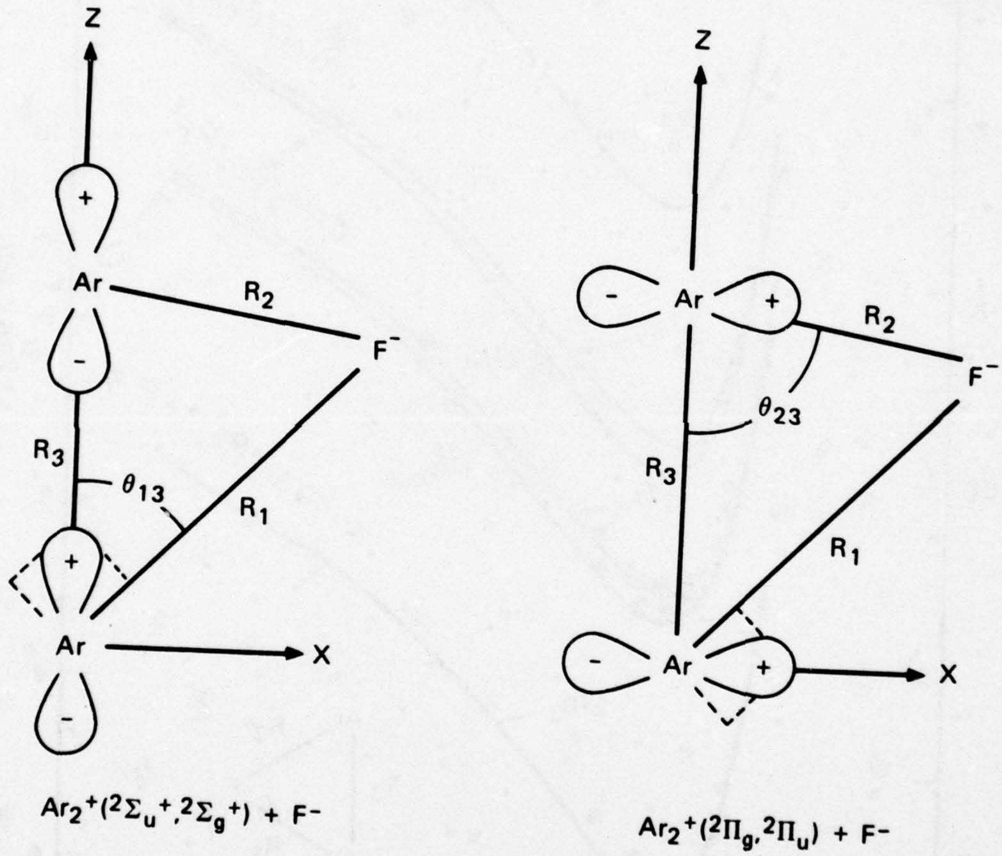
Graphical Data. A-1.13. Electronic states of XeI without spin-orbit coupling corrections.



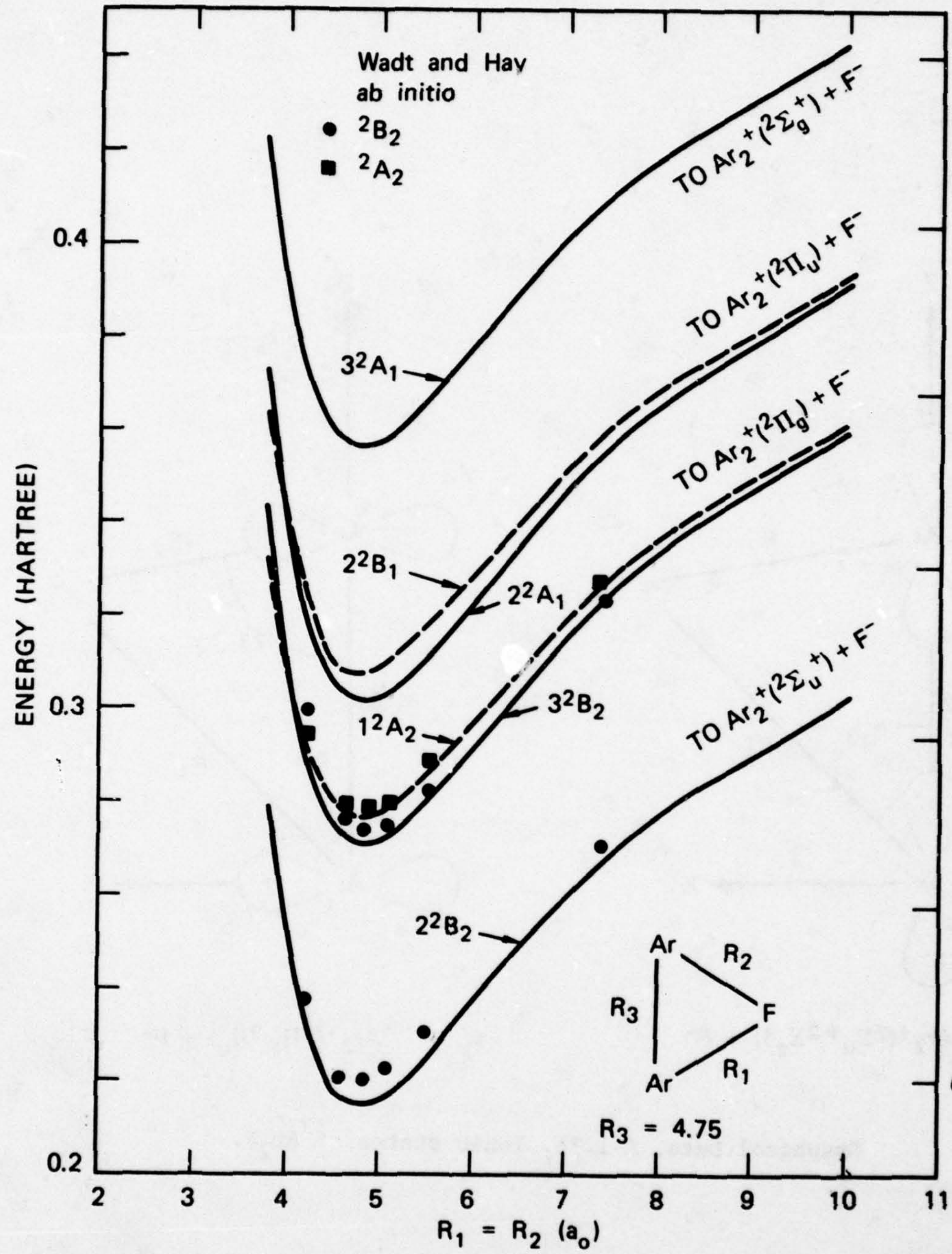
Graphical Data. A-1.14. Electronic states of XeI including spin-orbit coupling.



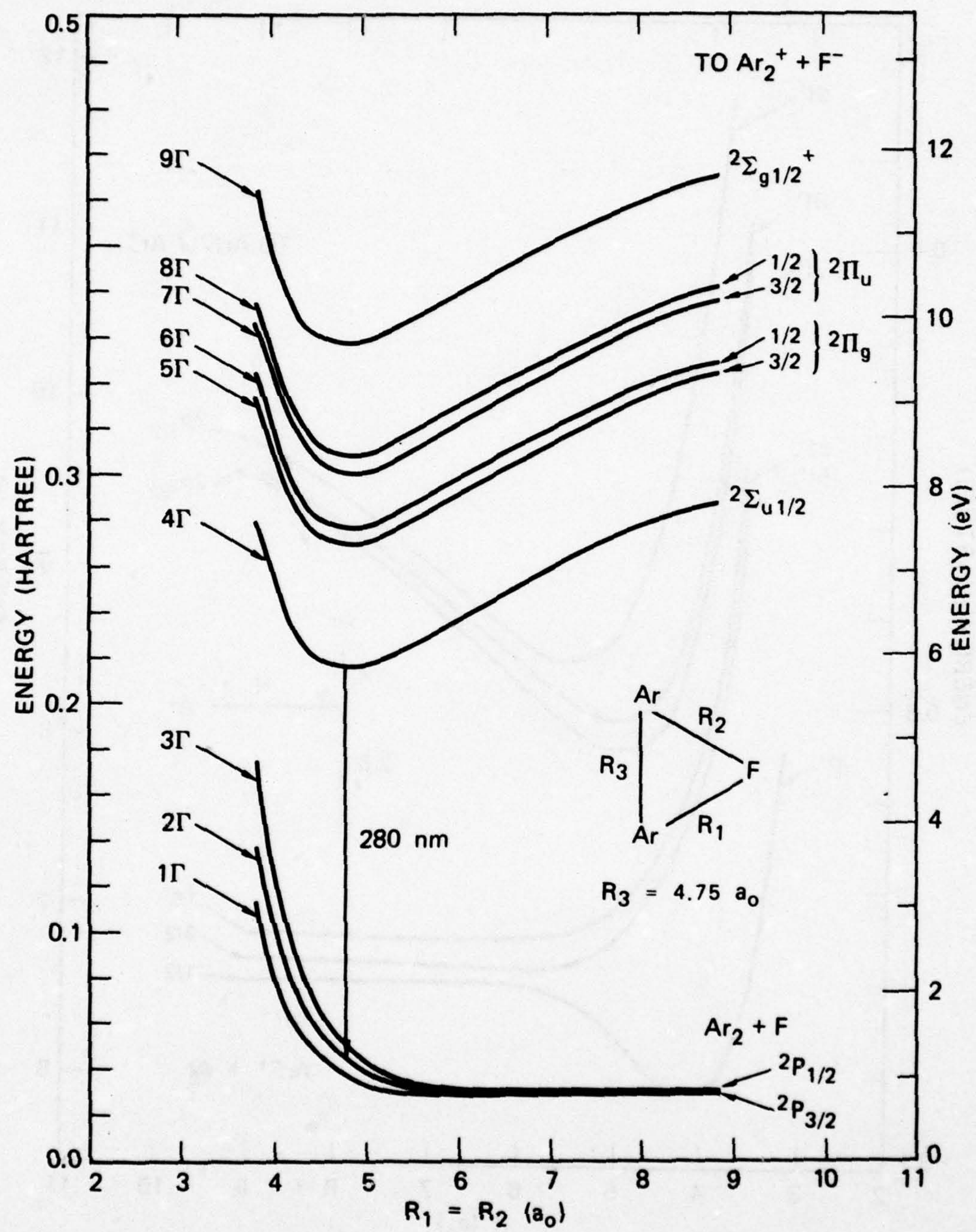
Graphical Data. A-1.15. Covalent states of Ar_2F.



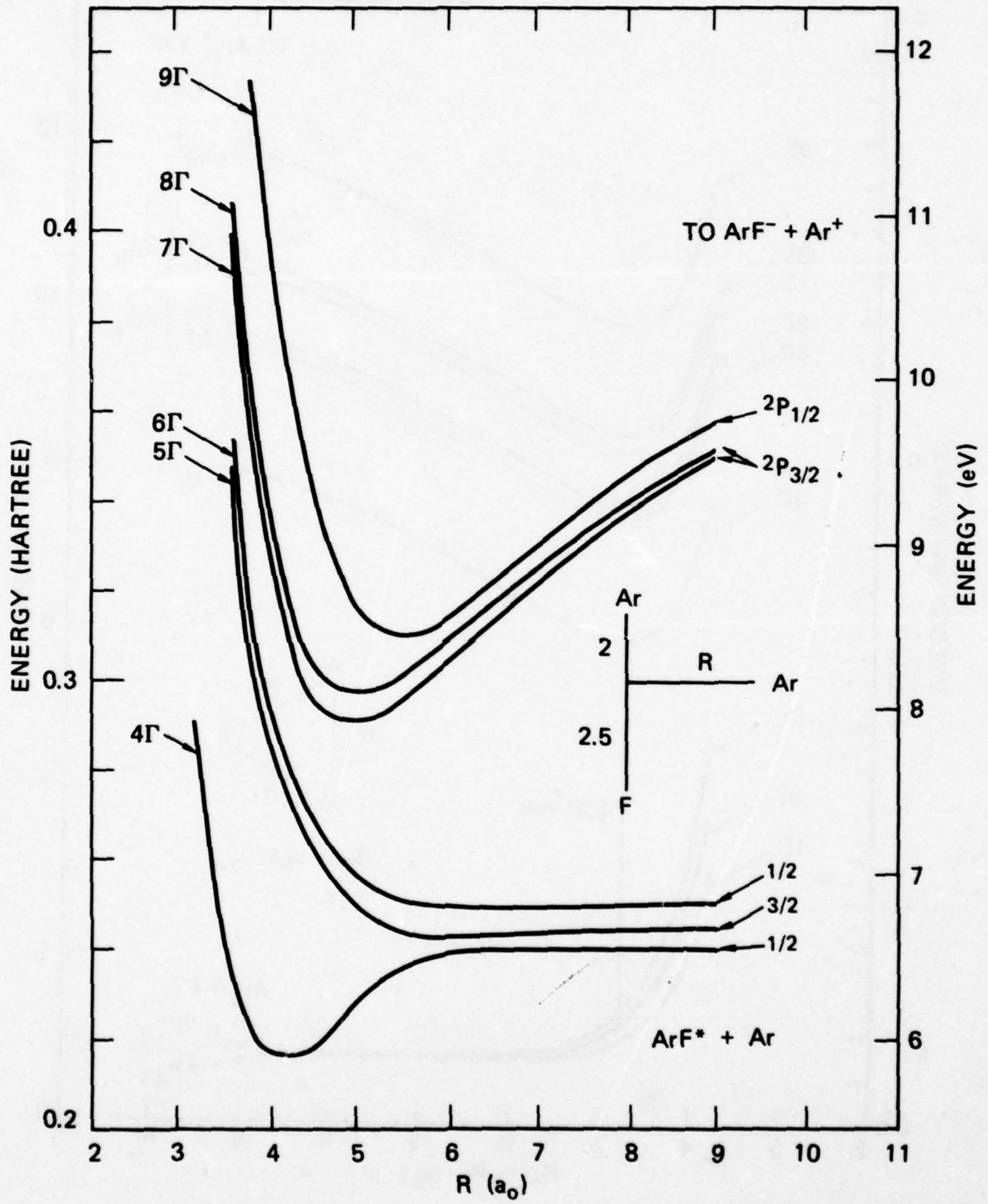
Graphical Data. A-1.16. Ionic states of Ar_2F.



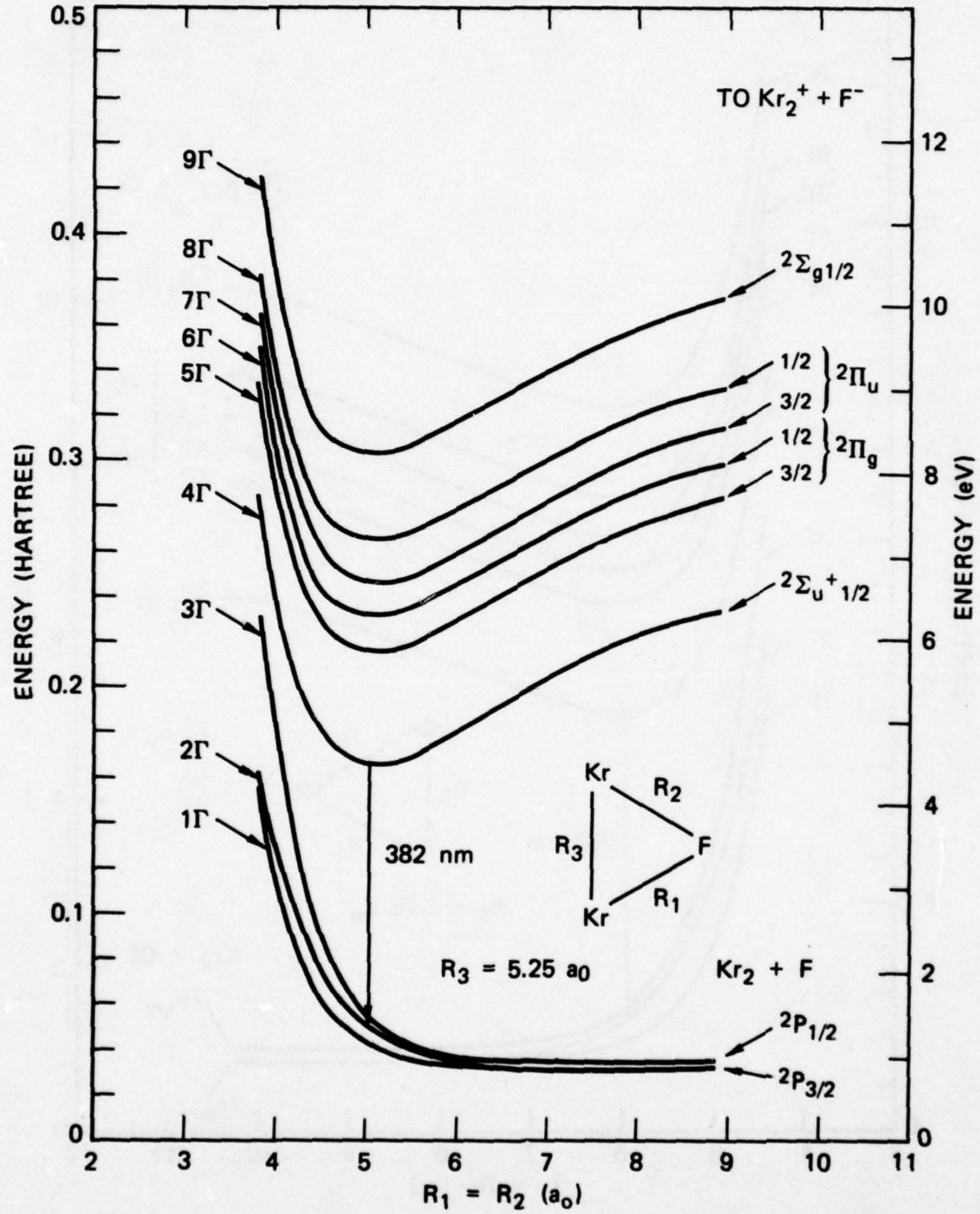
Graphical Data. A-1.17. Diatomics-in-molecules potential surfaces for the ionic states of Ar_2F without spin-orbit.



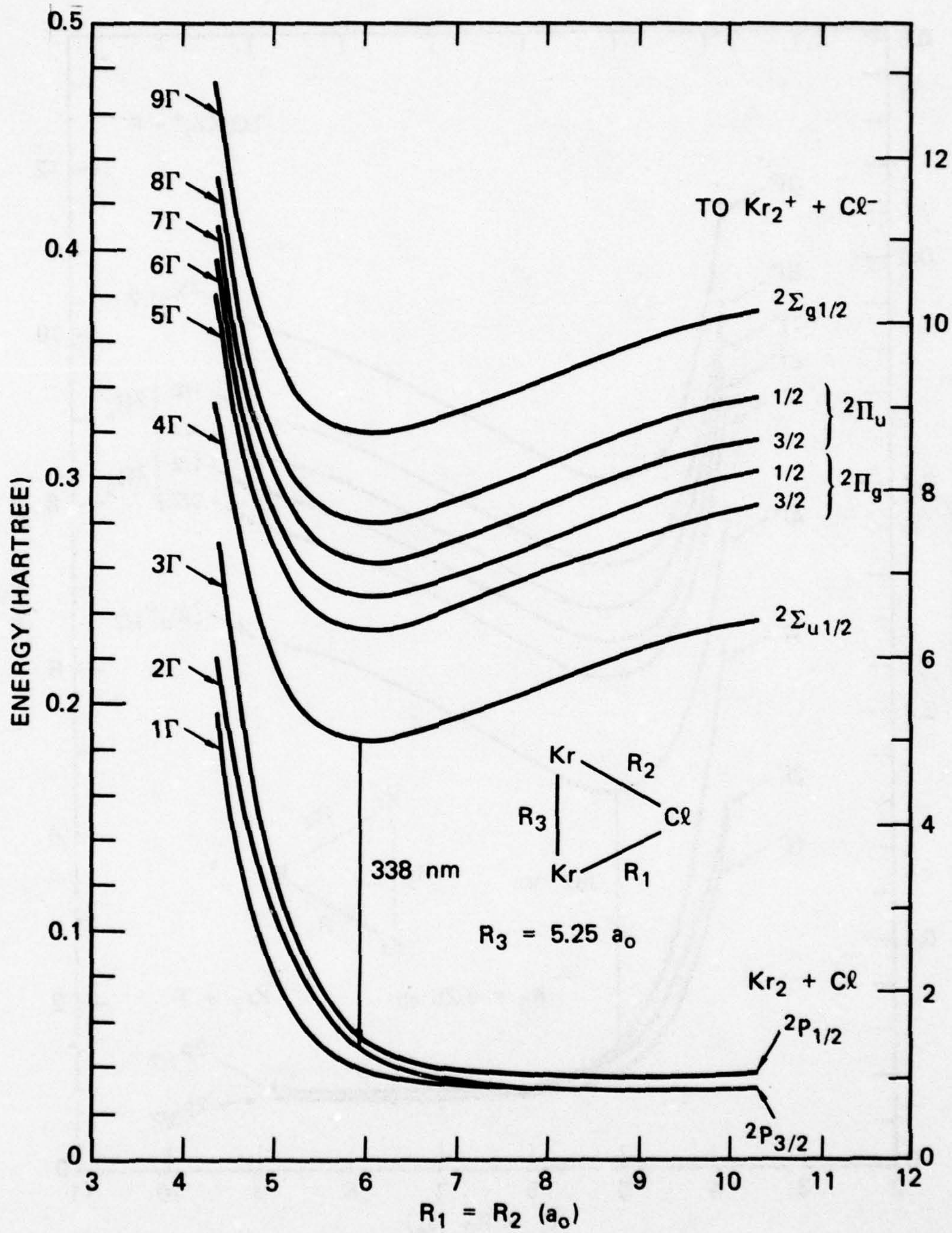
Graphical Data. A-1.18. Diatomics-in-molecules potential surfaces for Ar_2F with spin-orbit.



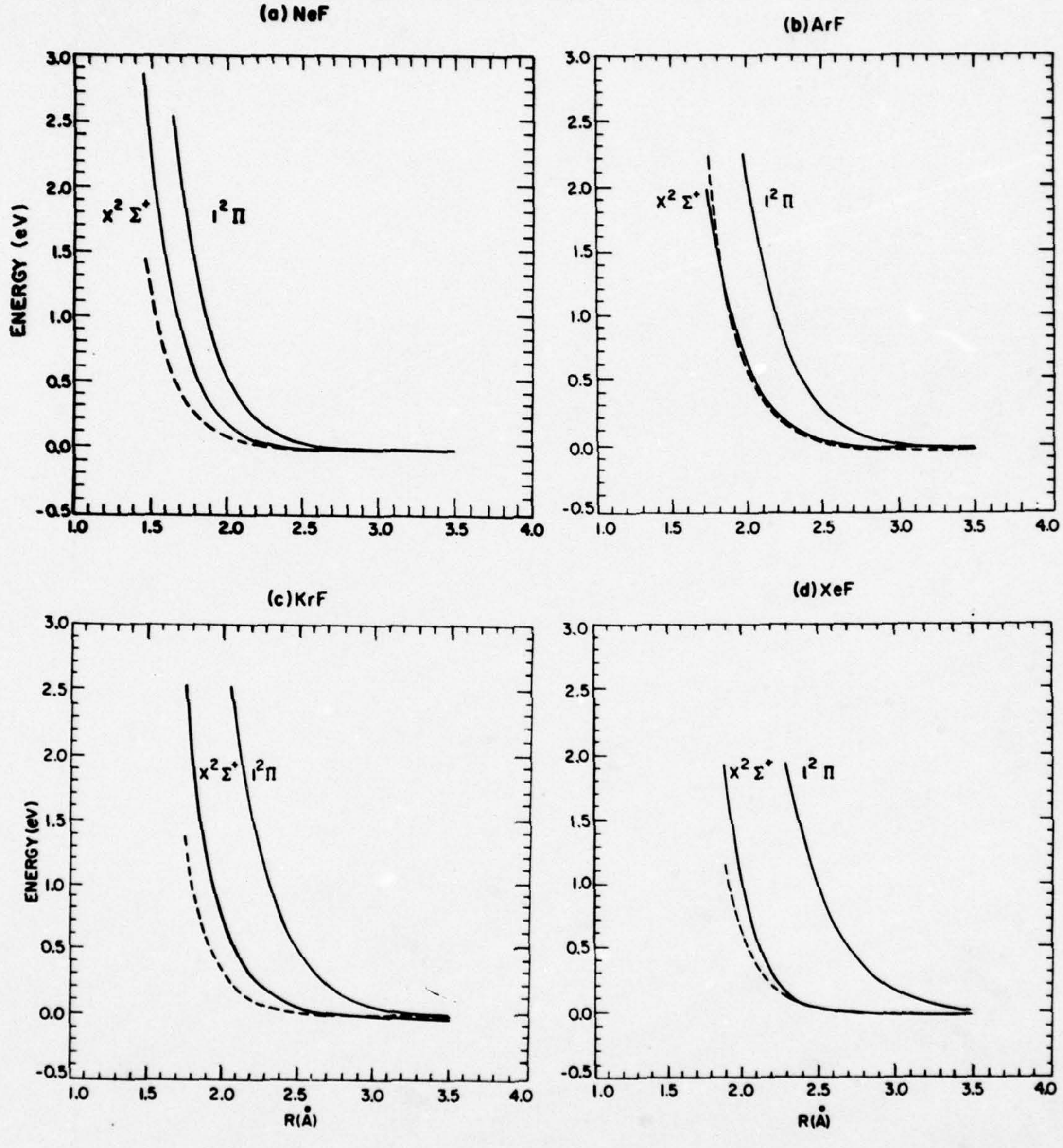
Graphical Data. A-1.19. Diatomics-in-molecules potential surfaces for the ionic states of Ar_2F with spin-orbit.



Graphical Data. A-1.20. Diatomics-in-molecules potential surfaces for Kr_2F with spin-orbit.



Graphical Data. A-1.21. Diatomics-in-molecules potential surfaces for $Kr_2C\ell$ with spin-orbit.



Graphical Data A-1.22. Comparison of the calculated potential energy curves for the covalent states of RgF (solid line) with the rare gas-fluorine interaction potential determined by Leonas (dashed line).

A-2. TOTAL ENERGIES OF THE COVALENT AND IONIC STATES OF THE RARE-GAS HALIDES (RgX) AS A FUNCTION OF INTERNUCLEAR SEPARATION

CONTENTS

Page

A-2. References

The tables in (A-2.1)-(A-2.19) are taken from the following sources:

(A-2.1)-(A-2.11):

T. H. Dunning, Jr., and P. J. Hay, "The Low-Lying States of the Rare-Gas Fluorides," J. Chem. Phys. (to be published).

(A-2.12)-(A-2.19):

P. J. Hay and T. H. Dunning, Jr., "Electronic States of the Xenon Halides," J. Chem. Phys. (to be published).

Tabular Data A-2.1. Total energies of the covalent and ionic states of NeF. (The energies are in hartrees and are relative to -227. hartrees; the distances are in bohrs).

R	Covalent States		Ionic States	
	$X^2\Sigma^+$	$1^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$
2.75	-0.83876	-0.73092	-0.37502	-0.37612
3.00	-0.88903	-0.82411	-0.46587	-0.46617
3.25	-0.91558	-0.87688	-0.51241	-0.51061
3.50	-0.92969	-0.90676	-0.53338	-0.52982
3.75	-0.93719	-0.92366	-0.53987	-0.53520
4.00	-0.94114	-0.93318	-0.53832	-0.53310
4.25	-0.94318	-0.93852	-0.53248	-0.52712
4.50	-0.94421	-0.94151	-0.52447	-0.51925
5.00	-0.94492	-0.94408	-0.50657	-0.50204
6.00	-0.94494	-0.94502	-0.47418	-0.47119
8.00	-0.94474	-0.94496	-0.43143	-0.43012
10.00	-0.94466	-0.94488	-0.40586	-0.40520
12.00	-0.94465	-0.94488	-0.38893	-0.38855
15.00	-0.94465	-0.94488	-0.37210	-0.37191

Tabular Data A-2.2. Total energies of the covalent and ionic states of NeF, with spin-orbit corrections. (The energies are in hartrees and are relative to -227. hartrees; the distances are in bohrs).

	Covalent States			Ionic States		
R	$X\frac{1}{2}$	$I\frac{3}{2}$	$II\frac{1}{2}$	$III\frac{1}{2}$	$II\frac{3}{2}$	$IV\frac{1}{2}$
2.75	-0.83899	-0.73154	-0.73030	-0.37675	-0.37750	-0.37339
3.00	-0.88927	-0.82472	-0.82348	-0.46724	-0.46755	-0.46381
3.25	-0.91583	-0.87749	-0.87624	-0.51319	-0.51199	-0.50882
3.50	-0.92995	-0.90737	-0.90611	-0.53393	-0.53120	-0.52827
3.75	-0.93747	-0.92427	-0.92299	-0.54033	-0.53658	-0.53374
4.00	-0.94145	-0.93380	-0.93248	-0.53875	-0.53448	-0.53168
4.25	-0.94354	-0.93914	-0.93777	-0.53290	-0.52850	-0.52571
4.50	-0.94464	-0.94212	-0.94069	-0.52490	-0 52063	-0.5.783
5.00	-0.94551	-0.94470	-0.94310	-0.50704	-0.50342	-0.50058
6.00	-0.94574	-0.94564	-0.94384	-0.47479	-0.47257	-0.46958
8.00	-0.94558	-0.94558	-0.94374	-0.43231	-0.43150	-0.42824
10.00	-0.94550	-0.94550	-0.94365	-0.42436	-0.42658	-0.40571
12.00	-0.94549	-0.94549	-0.94365	-0.39006	-0.38994	-0.38643
15.00	-0.94549	-0.94549	-0.94365	-0.37329	-0.37329	-0.36972

Tabular Data A-2.3. Total energies of the covalent and ionic states of ArF. (The energies are in hartrees and are relative to -625. hartrees; the distances are in bohrs).

	Covalent States		Ionic States	
R	$X^2\Sigma^+$	$1^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$
3.25	-1.10251	-0.97809	-0.77623	-0.80534
3.50	-1.13689	-1.05293	-0.85290	-0.87148
4.00	-1.16764	-1.13258	-0.92413	-0.92588
4.25	-1.17412	-1.15201	-0.93613	-0.93303
4.50	-1.17786	-1.16403	-0.93969	-0.93363
4.75	-1.18000	-1.17138	-0.93815	-0.93046
5.00	-1.18119	-1.17585	-0.93370	-0.92530
5.50	-1.18218	-1.18018	-0.92105	-0.91274
6.00	-1.18240	-1.18171	-0.90741	-0.90008
7.00	-1.18231	-1.18236	-0.88331	-0.87812
8.00	-1.18219	-1.18237	-0.86446	-0.86085
10.00	-1.18197	-1.18220	-0.83811	-0.83627
12.00	-1.18192	-1.18215	-0.82079	-0.81973
15.00	-1.18192	-1.18215	-0.80370	-0.80316
20.00	-1.18192	-1.18215	-0.78678	-0.78656

Tabular Data A-2.4. Total energies of the covalent and ionic states of ArF, with spin-orbit corrections. (The energies are in hartrees and are relative to -625. hartrees; the distances are in bohrs).

	Covalent States			Ionic States		
R	$X\frac{1}{2}$	$I\frac{3}{2}$	$II\frac{1}{2}$	$III\frac{1}{2}$	$II\frac{3}{2}$	$IV\frac{1}{2}$
3.25	-1.10274	-0.97870	-0.97747	-0.80374	-0.80775	-0.77589
3.50	-1.13712	-1.05355	-1.05231	-0.87009	-0.87388	-0.85236
4.00	-1.16789	-1.13319	-1.13194	-0.92711	-0.92828	-0.92096
4.25	-1.17438	-1.15262	-1.15136	-0.93758	-0.93543	-0.92963
4.50	-1.17814	-1.16464	-1.16336	-0.94074	-0.93603	-0.93064
4.75	-1.18030	-1.17200	-1.17069	-0.93904	-0.93286	-0.92762
5.00	-1.18154	-1.17646	-1.17511	-0.93455	-0.92770	-0.92251
5.50	-1.18265	-1.18079	-1.17932	-0.92190	-0.91515	-0.90995
6.00	-1.18302	-1.18232	-1.18070	-0.90834	-0.90249	-0.89721
7.00	-1.18310	-1.18298	-1.18118	-0.88445	-0.88052	-0.87503
8.00	-1.18301	-1.18299	-1.18116	-0.86582	-0.86325	-0.85754
10.00	-1.18281	-1.18281	-1.18097	-0.83983	-0.83867	-0.83261
12.00	-1.18276	-1.18276	-1.18092	-0.82271	-0.82213	-0.81587
15.00	-1.18276	-1.18276	-1.18092	-0.80577	-0.80556	-0.79914
20.00	-1.18276	-1.18276	-1.18092	-0.78896	-0.78896	-0.78244

Tabular Data A-2.5. Total energies of the covalent and ionic states of KrF. (The energies are in hartrees and are relative to -2850. hartrees; the distances are in bohrs).

	Covalent States		Ionic States	
R	$X^2\Sigma^+$	$1^2\Pi$	$2^2\Sigma^+$	$1^2\Pi$
3.25	-1.19536	-1.03749	-0.85987	-0.89942
3.50	-1.24083	-1.12327	-0.95960	-0.99316
3.75	-1.26620	-1.18309	-1.02422	-1.04698
4.00	-1.28015	-1.22372	-1.06412	-1.07612
4.25	-1.28776	-1.25059	-1.08666	-1.09006
4.50	-1.29201	-1.26799	-1.09756	-1.09496
4.75	-1.29442	-1.27909	-1.10083	-1.09447
5.00	-1.29580	-1.28608	-1.09938	-1.09090
5.25	-1.29659	-1.29045	-1.09514	-1.08564
5.50	-1.29702	-1.29317	-1.08932	-1.07954
6.00	-1.29736	-1.29588	-1.07637	-1.06718
7.00	-1.29731	-1.29720	-1.05205	-1.04523
8.00	-1.29715	-1.29730	-1.03279	-1.02795
10.00	-1.29688	-1.29710	-1.00591	-1.00341
12.00	-1.29680	-1.29702	-0.98833	-0.98690
15.00	-1.29679	-1.29702	-0.97107	-0.97034
20.00	-1.29679	-1.29702	-0.95407	-0.95376

Tabular Data A-2.6. Total energies of the covalent and ionic states of KrF, with spin-orbit corrections. (The energies are in hartrees and are relative to -2850. hartrees; the distances are in bohrs).

	Covalent States			Ionic States		
R	$X\frac{1}{2}$	$I\frac{3}{2}$	$II\frac{1}{2}$	$III\frac{1}{2}$	$II\frac{3}{2}$	$IV\frac{1}{2}$
3.25	-1.19559	-1.03810	-1.03687	-0.89532	-0.90788	-0.85612
3.50	-1.24106	-1.12389	-1.12265	-0.98973	-1.00163	-0.95519
3.75	-1.26644	-1.18370	-1.18246	-1.04541	-1.05545	-1.01794
4.00	-1.28039	-1.22433	-1.23309	-1.07791	-1.08458	-1.05447
4.25	-1.28801	-1.25120	-1.24995	-1.09618	-1.09852	-1.07269
4.50	-1.29226	-1.26861	-1.26735	-1.10500	-1.10343	-1.07968
4.75	-1.29469	-1.27970	-1.27843	-1.10727	-1.0293	-1.08018
5.00	-1.29610	-1.28670	-1.28540	-1.10535	-1.09936	-1.07709
5.25	-1.29692	-1.29107	-1.28973	-1.10089	-1.09410	-1.07203
5.50	-1.29740	-1.29378	-1.29240	-1.09503	-1.08801	-1.06599
6.00	-1.29788	-1.29649	-1.29497	-1.08219	-1.07565	-1.05351
7.00	-1.29805	-1.29781	-1.29607	-1.05838	-1.05369	-1.03105
8.00	-1.29797	-1.29791	-1.29609	-1.03961	-1.03642	-1.01328
10.00	-1.29772	-1.29772	-1.29588	-1.01338	-1.01188	-0.98809
12.00	-1.29764	-1.29764	-1.29579	-0.99612	-0.99536	-0.97126
15.00	-1.29763	-1.29763	-1.29579	-0.97909	-0.97880	-0.95448
20.00	-1.29763	-1.29763	-1.29579	-0.97909	-0.97880	-0.95448

Tabular Data A-2.7. Total energies of the covalent and ionic states of XeF. (The energies are in hartrees and are relative to -7330. hartrees; the distances are in bohrs).

	Covalent States		Ionic States	
R	$X^2\Sigma^+$	$1^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$
3.50	-1.14321	-0.99857	-0.84242	-0.88036
3.75	-1.17920	-1.05999	-0.92629	-0.96604
4.00	-1.19788	-1.10526	-0.98420	-1.01694
4.50	-1.21108	-1.16394	-1.04624	-1.05700
4.75	-1.21279	-1.18109	-1.05933	-1.06145
5.00	-1.21351	-1.19269	-1.06480	-1.06092
5.25	-1.21387	-1.20040	-1.06524	-1.05760
5.50	-1.21409	-1.20544	-1.06246	-1.05273
6.00	-1.21431	-1.21081	-1.05197	-1.04101
7.00	-1.21436	-1.21387	-1.02792	-1.01880
8.00	-1.21426	-1.21433	-1.00795	-1.00124
10.00	-1.21411	-1.21432	-0.98011	-0.97654
12.00	-1.21402	-1.21424	-0.96211	-0.96006
15.00	-1.21400	-1.21423	-0.94458	-0.94353
20.00	-1.21400	-1.21423	-0.92742	-0.92698

Tabular Data A-2.8. Total energies of the covalent and ionic states of XeF, with spin-orbit corrections. (The energies are in hartrees and are relative to -7330. hartrees; the distances are in bohrs).

	Covalent States			Ionic States		
	$X\frac{1}{2}$	$I\frac{3}{2}$	$II\frac{1}{2}$	$III\frac{1}{2}$	$II\frac{3}{2}$	$IV\frac{1}{2}$
3.50	-1.14344	-0.99919	-0.99795	-0.87885	-0.89680	-0.82836
3.75	-1.17943	-1.06061	-1.05937	-0.96405	-0.98249	-0.91273
4.00	-1.19812	-1.10588	-1.10464	-1.01699	-1.03338	-0.96858
4.50	-1.21132	-1.16456	-1.16331	-1.06659	-1.07344	-1.02108
4.75	-1.21304	-1.18170	-1.18045	-1.07621	-1.07789	-1.02900
5.00	-1.21377	-1.19331	-1.19204	-1.07971	-1.07736	-1.03045
5.25	-1.21515	-1.20101	-1.19973	-1.07907	-1.07404	-1.02821
5.50	-1.21439	-1.20606	-1.20475	-1.07574	-1.06917	-1.02389
6.00	-1.21470	-1.21142	-1.21002	-1.06494	-1.05745	-1.01248
7.00	-1.21502	-1.21449	-1.21283	-1.04136	-1.03524	-0.98980
8.00	-1.21505	-1.21494	-1.21315	-1.02204	-1.01769	-0.97160
10.00	-1.21495	-1.21494	-1.21310	-0.95511	-0.99298	-0.94598
12.00	-1.21486	-1.21486	-1.21301	-0.97759	-0.97650	-0.92902
15.00	-1.21485	-1.21485	-1.21300	-0.96038	-0.95997	-0.91217
20.00	-1.21485	-1.21485	-1.21300	-0.94342	-0.94342	-0.89541

Tabular Data A-2.9. Characterization of the potential curves of the covalent states of the rare gas fluorides at the R_e's of the ionic states. (The energies are in eV's; distances are in angstroms).

Molecule	Ionic State	$X\frac{1}{2}$		$I\frac{3}{2}$		$II\frac{1}{2}$	
		$\Delta E(R_e)$	$(\partial E/\partial R)_{R_e}$	$\Delta E(R_e)$	$(\partial E/\partial R)_{R_e}$	$\Delta E(R_e)$	$(\partial E/\partial R)_{R_e}$
NeF	$III\frac{1}{2}$	0.19	-1.02	- -	- -	0.49	-2.38
	$II\frac{3}{2}$	- -	- -	0.54	-2.54	- -	- -
	$IV\frac{1}{2}$	0.20	-1.09	- -	- -	0.52	-2.52
ArF	$III\frac{1}{2}$	0.12	-0.58	- -	- -	0.46	-1.92
	$II\frac{3}{2}$	- -	- -	0.61	-2.38	- -	- -
	$IV\frac{1}{2}$	0.16	-0.72	- -	- -	0.57	-2.31
KrF	$III\frac{1}{2}$	0.082	-0.40	- -	- -	0.48	-1.89
	$II\frac{3}{2}$	- -	- -	0.67	-2.40	- -	- -
	$IV\frac{1}{2}$	0.10	-0.48	- -	- -	0.59	-2.21
XeF	$III\frac{1}{2}$	0.025	-0.093	- -	- -	0.50	-1.75
	$II\frac{3}{2}$	- -	- -	0.78	-2.52	- -	- -
	$IV\frac{1}{2}$	0.033	-0.13	- -	- -	0.63	-2.14

Tabular Data A-2.10. Crossing points and energies of the III 1/2 - II 3/2 curve crossings in the rare gas fluorides. (Units are as indicated).

Molecule	R_c (Å)	E_c (hartrees)	Energy Relative to Minimum of $III\frac{1}{2}$ state	Energy Relative to Minimum of $II\frac{3}{2}$ state
NeF	1.62	-227.48439	1.53 ev	1.42 ev
ArF	2.17	-625.93274	0.22	0.099
KrF	2.32	-2851.10196	0.14	0.048
XeF	2.56	-7331.07828	0.043	0.000

Tabular Data A-2.11. Calculated and experimental separated atom limits for the ionic states of the rare gas fluorides. (All quantities in eV's). (Experimental states have been averaged over spin-orbit components).

Molecule	Separated Atom Limit Calc[a]	Separated Atom Limit Expt[b]	Correction to ΔE_{em}
NeF	17.39, 17.41	18.13	+0.73
ArF	12.11, 12.13	12.35	+0.23
KrF	10.69, 10.70	10.76	+0.06
XeF	9.16, 9.18	9.10	+0.07

[a] The first number was calculated from the $^2\Sigma^+$ energies, the second from the $^2\Pi$ energies.

[b] Reference

Tabular Data A-2.12. Total energies (relative to -7690. hartrees) as a function of R (in bohr) for the electronic states of XeCℓ without spin-orbit corrections.

R	$X\ ^2\Sigma^+$	$1\ ^2\Pi$	$2\ ^2\Sigma^+$	$2\ ^2\Pi$
4.50	-1.20330	-1.10838	-0.96211	-0.98764
4.75	-1.22621	-1.15439	-1.01030	-1.03026
5.00	-1.24020	-1.18726	-1.04355	-1.05701
5.50	-1.25362	-1.22662	-1.07918	-1.08156
5.75	-1.25661	-1.23776	-1.08673	-1.08533
6.00	-1.25839	-1.24537	-1.08994	-1.08591
6.25	-1.25945	-1.25053	-1.09014	-1.08443
6.50	-1.26007	-1.25400	-1.08835	-1.08167
7.00	-1.26064	-1.25787	-1.08150	-1.07426
8.00	-1.26077	-1.26028	-1.06454	-1.05841
15.00	-1.26035	-1.26058	-1.00158	-1.00055
20.00	-1.26035	-1.26058	-0.98437	-0.98394

Tabular Data A-2.13. Total energies (relative to -7690. hartree) as a function of R (in bohr) for the electronic states of XeCℓ with spin-orbit corrections.

R	I 1/2	I 3/2	II 1/2	III 1/2	II 3/2	IV 1/2
4.50	-1.20357	-1.10838	-1.10701	-0.99026	-1.00408	-0.94392
4.75	-1.22648	-1.15439	-1.15300	-1.03523	-1.04670	-0.98976
5.00	-1.24049	-1.18726	-1.18586	-1.06515	-1.07344	-1.01984
5.50	-1.25398	-1.22662	-1.22516	-1.09616	-1.09799	-1.04901
5.75	-1.25701	-1.23776	-1.23625	-1.10242	-1.10177	-1.05408
6.00	-1.25886	-1.24537	-1.24379	-1.10480	-1.10235	-1.05548
6.25	-1.26001	-1.25053	-1.24886	-1.10451	-1.10087	-1.05450
6.50	-1.26075	-1.25400	-1.25221	-1.10244	-1.09811	-1.05201
7.00	-1.26158	-1.25787	-1.25582	-1.09544	-1.09070	-1.04476
8.00	-1.26212	-1.26028	-1.25781	-1.07878	-1.07485	-1.02859
15.00	-1.26192	-1.26058	-1.25790	-1.01739	-1.01699	-0.96918
20.00	-1.26192	-1.26058	-1.25790	-1.00037	-1.00037	-0.95237

Tabular Data A-2.14.

Total energies (relative to -9800. hartree) as a function of R (in bohr) for the covalent and ionic states of XeBr without spin-orbit corrections.

R	$X\ ^2\Sigma^+$	$1\ ^2\Pi$	$2\ ^2\Sigma^+$	$2\ ^2\Sigma$
4.50	-4.00233	-3.89332	-3.73870	-3.75980
5.00	-4.06063	-3.99624	-3.84346	-3.85950
5.50	-4.08369	-4.04883	-3.89479	-3.90071
5.75	-4.08914	-4.06412	-3.90788	-3.90965
6.00	-4.09249	-4.07475	-3.91538	-3.91395
6.25	-4.09454	-4.08208	-3.91885	-3.91515
6.50	-4.09580	-4.08709	-3.91947	-3.91428
6.75	-4.09656	-4.09051	-3.91815	-3.91208
7.00	-4.09701	-4.09282	-3.91556	-3.90908
8.00	-4.09749	-4.09660	-3.90054	-3.89461
10.00	-4.09727	-4.09738	-3.87366	-3.87017
20.00	-4.09705	-4.09724	-3.82053	-3.82009

Tabular Data A-2.15. Total energies (relative to -9800. hartree) as a function of R (in bohr) for the electronic states of XeBr with spin-orbit corrections.

R	I 1/2	I 3/2	II 1/2	III 1/2	II 3/2	IV 1/2
4.50	-4.00306	-3.89892	-3.88718	-3.76426	-3.77624	-3.71867
5.00	-4.06170	-4.00184	-3.98976	-3.86633	-3.87594	-3.82107
5.50	-4.08537	-4.05443	-4.04175	-3.91310	-3.91714	-3.86682
5.75	-4.09125	-4.06972	-4.05661	-3.92463	-3.29608	-3.87732
6.00	-4.09509	-4.08034	-4.06674	-3.93105	-3.93039	-3.88271
6.25	-4.09769	-4.08767	-4.07353	-3.93381	-3.93159	-3.88462
6.50	-4.09947	-4.09269	-4.07801	-3.93398	-3.93072	-3.88419
6.75	-4.10071	-4.09610	-4.08095	-3.93241	-3.92852	-3.88225
7.00	-4.10157	-4.09842	-4.08286	-3.92971	-3.92551	-3.87936
8.00	-4.10293	-4.10219	-4.08575	-3.91484	-3.91104	-3.86474
10.00	-4.10304	-4.10298	-4.08622	-3.88869	-3.88661	-3.83958
20.00	-4.10284	-4.10284	-4.08605	-3.83653	-3.83653	-3.78852

Tabular Data A-2.16. Total energies (relative to -14149. hartree) as a function of R (in bohr) for the covalent and ionic states of XeI without spin-orbit corrections.

R	$X\ {}^2\Sigma^+$	$1\ {}^2\Pi$	$2\ {}^2\Sigma^+$	$2\ {}^2\Pi$
5.00	-0.41153	-0.33024	-0.17397	-0.17953
5.50	-0.45650	-0.40876	-0.24921	-0.25397
6.00	-0.47562	-0.44940	-0.28589	-0.28585
6.50	-0.48361	-0.46985	-0.30021	-0.29636
6.75	-0.48562	-0.47577	-0.30232	-0.29729
7.00	-0.48690	-0.47988	-0.30230	-0.29651
7.50	-0.48821	-0.48467	-0.29829	-0.29199
8.00	-0.48867	-0.48693	-0.29175	-0.28573
10.00	-0.48865	-0.48867	-0.26521	-0.26163
15.00	-0.48838	-0.48857	-0.22880	-0.22776
20.00	-0.48837	-0.48856	-0.21145	-0.21102

Tabular Data A-2.17. Total energies (relative to -14149. hartree) as a function of R (in bohr) for the electronic states of XeI with spin-orbit corrections.

R	I 1/2	I 3/2	II 1/2	III 1/2	II 3/2	IV 1/2
5.00	-0.41450	-0.34178	-0.31591	-0.19214	-0.19597	-0.14579
5.50	-0.46088	-0.42031	-0.39303	-0.26707	-0.27041	-0.22054
6.00	-0.48186	-0.46094	-0.43179	-0.30202	-0.30228	-0.25415
6.50	-0.49177	-0.48140	-0.45034	-0.31512	-0.31279	-0.26587
6.75	-0.49459	-0.48731	-0.45544	-0.31689	-0.31372	-0.26716
7.00	-0.49654	-0.49142	-0.45888	-0.31664	-0.31294	-0.26660
7.50	-0.49878	-0.49622	-0.46274	-0.31249	-0.30843	-0.26222
8.00	-0.49979	-0.49848	-0.46446	-0.30603	-0.30217	-0.25589
10.00	-0.50033	-0.50022	-0.46563	-0.28021	-0.27806	-0.23106
15.00	-0.50011	-0.50011	-0.46547	-0.24460	-0.24420	-0.19639
20.00	-0.50010	-0.50010	-0.46547	-0.22745	-0.22745	-0.17945

Tabular Data A-2.18. Relative coefficients (C_{Π}) of the $1\,^2\Pi$ state in the covalent I 1/2 states of the xenon halides. (The coefficients of the $1\,^2\Sigma^+$ state are determined by the relation $(C_{\Sigma})^2 + (C_{\Pi})^2 = 1$).

R	XeF	XeCl	XeBr	XeI
3.50	0.0059	--	--	--
4.00	0.0072	--	--	--
4.50	0.0181	0.0196	0.0684	--
4.75	--	0.0257	--	--
5.00	0.0400	0.0346	0.1106	0.1679
5.25	0.0604	--	--	--
5.50	0.0905	0.0658	0.1845	0.2484
5.75	--	0.0915	0.2350	--
6.00	0.1893	0.1266	0.2917	0.3478
6.25	--	0.1723	0.3495	--
6.50	--	0.2278	0.4029	0.4385
6.75	--	--	0.4478	0.4735
7.00	0.4432	0.3508	0.4831	0.5009
7.50	--	--	--	0.5369
8.00	0.5443	0.5109	0.5528	0.5561
10.00	0.5748	--	0.5745	0.5755
∞	0.5773	0.5773	0.5773	0.5773

Tabular Data. A-2.19. Relative coefficients (C_{Π}) of the $2\,^2\Pi$ state in the ionic III 1/2 states of the xenon halides. (The coefficients of the $2\,^2\Sigma^+$ state are determined by the relation $(C_{\Sigma})^2 + (C_{\Pi})^2 = 1$).

R	XeF	XeCl	XeBr	XeI
3.50	0.8494	--	--	--
4.00	0.8577	--	--	--
4.50	0.6687	0.7794	0.7488	--
4.75	--	0.7404	--	--
5.00	0.5500	0.6904	0.7108	0.6261
5.25	0.5214	--	--	--
5.50	0.5060	0.6000	0.6290	0.6195
5.75	--	0.5696	0.5951	--
6.00	0.4971	0.5489	0.5694	0.5804
6.25	--	0.5359	0.5515	--
6.50	--	0.5285	0.5399	0.5503
6.75	--	--	0.5332	0.5411
7.00	0.5104	0.5244	0.5300	0.5353
7.50	--	--	--	0.5314
8.00	0.5284	0.5327	0.5343	0.5335
10.00	0.5526	--	0.5531	0.5523
∞	0.5774	0.5774	0.5774	0.5774

A-3. SPECTROSCOPIC CONSTANTS FOR THE IONIC STATES OF THE XENON-HALIDES AND RARE-GAS-FLUORIDES (RgF). SPIN-ORBIT PARAMETERS FOR RgF.

CONTENTS

Page

A-3. References

The tables and figures in (A-3.1)-(A-3.12) are taken from the following sources:

(A-3.1), (A-3.2), (A-3.12):

P. J. Hay and T. H. Dunning, Jr., "Electronic States of the Xenon-Halides," J. Chem. Phys. (to be published).

(A-3.3)-(A-3.7), (A-3.9)-(A-3.11):

T. H. Dunning, Jr., and P. J. Hay, "The Low-Lying States of the Rare-Gas Fluorides," J. Chem. Phys. (to be published).

Tabular Data. A-3.1. Calculated spectroscopic constants for the ionic states of the xenon halides without spin-orbit corrections.

	T_e(eV)	D_e(eV)	R_e(Å)	k_e(10^{-5} dyne/cm)	ω_e(cm^{-1})	$\omega_e x_e$(cm^{-1})	B_e(cm^{-1})
$Xe^{132}F^{19}$							
$2^2\Sigma^+$	4.04	5.12	2.72	0.95	311.	1.2	0.1368
$2^2\Pi$	4.15	5.03	2.56	1.01	321.	2.4	0.1552
$Xe^{131}Cl^{35}$							
$2^2\Sigma^+$	4.63	4.24	3.25	0.588	190.	0.63	0.05773
$2^2\Pi$	4.75	4.13	3.14	0.577	188.	0.85	0.06194
$Xe^{132}Br^{79}$							
$2^2\Sigma^+$	4.84	4.05	3.41	0.528	135.	0.39	0.02940
$2^2\Pi$	4.95	3.95	3.31	0.508	132.	0.44	0.03118
$Xe^{132}I^{127}$							
$2^2\Sigma^+$	5.06	3.84	3.63	0.445	108.	0.24	0.01974
$2^2\Pi$	5.20	3.71	3.57	0.425	106.	0.30	0.02047

Tabular Data. A-3.2. Calculated spectroscopic constants for the ionic states of the xenon halides with spin-orbit correction.

	T_e(eV)	D_e(eV)	R_e(Å)	$k_e(10^{-5}$ dyne/ cm)	$\omega_e(cm^{-1})$	$\omega_e x_e(cm^{-1})$	$B_e(cm^{-1})$
$Xe^{132}F^{19}$							
III 1/2	3.67	5.07	2.68	0.90	303.	1.2	0.1408
II 3/2	3.72	5.03	2.56	1.01	321.	2.4	0.1552
IV 1/2	5.02	5.04	2.62	1.01	321.	2.3	0.1480
$Xe^{132}Cl^{35}$							
III 1/2	4.27	4.21	3.22	0.57	188.	0.66	0.05876
II 3/2	4.34	4.14	3.14	0.58	188.	0.85	0.06194
IV 1/2	5.[illegible]2	4.17	3.18	0.58	189.	0.80	0.06044
$Xe^{132}Br^{79}$							
III 1/2	4.59	4.02	3.38	0.51	133.	0.39	0.02984
II 3/2	4.66	3.95	3.31	0.51	132.	0.44	0.03118
IV 1/2	5.94	3.98	3.34	0.52	133.	0.44	0.03055
$Xe^{132}I^{127}$							
III 1/2	4.98	3.80	3.62	0.436	107.	0.24	0.01992
II 3/2	5.07	3.71	3.57	0.425	106.	0.30	0.02047
IV 1/2	6.34	3.75	3.59	0.430	106.	0.28	0.02023

Tabular Data. A-3.3. Calculated spectroscopic constants for the ionic states of the rare gas fluorides. Units are as indicated.

	$Ne^{20}F^{19}$		$Ar^{40}F^{19}$		$Kr^{84}F^{19}$		$Xe^{132}F^{19}$	
	$2^2\Sigma^+$	$2^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$
E_e, hartrees	-227.54005	-227.53524	-625.93972	-625.93397	-2851.10086	-2851.09527	-7331.06553	-7331.06170
T_e,eV	11.01	11.15	6.59	6.75	5.33	5.49	4.04	4.15
D_e	6.38	6.26	5.52	5.37	5.36	5.21	5.12	5.03
R_e, Å	2.01	2.00	2.40	2.33	2.53	2.43	2.72	2.56
k_e,10^{-5} dynes/cm	1.68	1.67	1.17	1.16	1.09	1.09	.95	1.01
ω_e, cm^{-1}	541.	539.	394.	392.	345.	346.	311.	321.
$\omega_e x_e$	4.2	4.9	2.7	3.1	1.8	2.4	1.2	2.4
B_e,cm^{-1}	.4268	.4328	.2281	.2415	.1703	.1845	.1368	.1552
α_e	.0048	.0052	.0019	.0021	.0012	.0014	.0008	.0012

Tabular Data A-3.4. Calculated spectroscopic constants for the ionic states of $Ne^{20}F^{19}$, with spin-orbit corrections. (Units are as indicated).

	$III\frac{1}{2}$	$II\frac{3}{2}$	$IV\frac{1}{2}$
E_e, hartrees	-227.54050	-227.53663	-227.53379
T_e, eV	11.02	11.13	11.20
D_e	6.36	6.26	6.28
R_e,Å	2.01	2.00	2.00
k_e,10^{-5} dynes/cm	1.68	1.67	1.67
ω_e,cm^{-1}	541.	539.	539.
$\omega_e x_e$	4.2	4.9	4.9
B_e,cm^{-1}	.4271	.4328	.4324
α_e	.0048	.0052	.0052

Tabular Data. A-3.5. Calculated spectroscopic constants for the ionic states of $Ar^{40}F^{19}$, with spin-orbit corrections. (Units are as indicated).

	$III\frac{1}{2}$	$II\frac{3}{2}$	$IV\frac{1}{2}$
E_e,hartrees	-625.94075	-625.93637	-625.93089
T_e,eV	6.58	6.70	6.85
D_e	5.49	5.37	5.40
R_e,Å	2.39	2.33	2.34
K_e,10^{-5} dynes/cm	1.16	1.16	1.23
ω_e, cm^{-1}	390.	392.	402.
$\omega_e x_e$	2.7	3.1	4.0
B_e,cm^{-1}	.2290	.2415	.2398
α_e	.0015	.0021	.0026

Tabular Data. A-3.6. Calculated and experimental spectroscopic constants for the ionic states of $Kr^{84}F^{19}$, with spin-orbit corrections. (Units are as indicated).

	$III\frac{1}{2}$ Calc	$III\frac{1}{2}$ "Expt"[a]	$II\frac{3}{2}$	$IV\frac{1}{2}$
E_e, hartrees	-2851.10727	----	-2851.10373	-2851.08054
T_e, eV	5.18	5.01	5.28	5.91
D_e	5.31	5.54	5.21	5.25
R_e, Å	2.51	2.27	2.43	2.46
k_e, 10^{-5} dynes/cm	1.05	----	1.09	1.13
ω_e, cm^{-1}	339.	310.	346.	352.
$\omega_e x_e$	1.7	1.2	2.4	2.7
B_e, cm^{-1}	.1730	.212	.1845	.1801
α_e	.0011	----	.0014	.0016

[a] Reference J.. T. Tellinghuisen, A. K. Hays, J. M. Hoffman and G. C. Tisone, J. Chem Phys. 65, 4473 (1976).

Tabular Data. A-3.7. Calculated and experimental spectroscopic constants for ionic states of $Xe^{123}F^{19}$, with spin-orbit corrections. (Units are as indicated).

	III 1/2		II 3/2	IV 1/2
	Calc	"Expt"[a]		
E_e, hartrees	-7331.07987	- -	-7331.07814	-7331.03053
T_e, eV	3.67	3.52	3.72	5.02
D_e	5.07	- -	5.03	5.04
R_e, Å	2.68	- -	2.56	2.62
k_e, 10^{-5}dynes/cm	.90	- -	1.01	1.01
ω_e, cm^{-1}	303.	308.	321.	321.
$\omega_e x_e$	1.2	1.516	2.4	2.3
B_e,cm^{-1}	.1408	- -	.1552	.1480
α_e	.0008	- -	.0012	.0012

[a]Reference
J. T. Tellinghuisen, G. C. Tisone, J. M. Hoffman and A. K. Hays, J. Chem. Phys. 64, 4796 (1976).

Tabular Data. A-3.8. Comparison of calculated spectroscopic constants of the III 1/2 state of the xenon halides with estimates from analysis of the fluorescence spectra.

	$\omega_e (cm^{-1})$		$R_e (\mathring{A})$		$D_e (eV)$	
	Calc.	Expt[a]	Calc.	Expt[a]	Calc.	Expt[a]
XeF	303	309	2.68	2.49	5.07	5.31
XeCl	188	195	3.22	2.94	4.21	4.53
XeBr	133	120	3.38	2.96	4.02	4.30
XeI	107	112	3.62	3.31	3.80	4.08

[a] J. Tellinghuisen, A. K. Hays, J. M. Hoffman and G. C. Tisone, J. Chem. Phys. 65, 4473 (1976).

Atom	λ^a
F	0.0167
Ne^+	0.0323
Ar^+	0.0592
Kr^+	0.222
Xe^+	0.435

Tabular Data. A-3.9. Spin-orbit parameters for fluorine and the rare gas ions. (The parameters are in eV).

Atom	λ
F	135
Cl	294
Br	1228
I	2534
Xe^+	3512

Tabular Data. A-3.10. Spin-orbit coupling parameters (in cm^{-1}) for the xenon halides. (λ is defined as $\frac{1}{3}\,[E(^2P_{1/2}) - E(^2P_{3/2})]$).

A-4. DIPOLE MOMENTS OF COVALENT AND IONIC STATES AND TRANSITION MOMENTS FOR IONIC-COVALENT TRANSITIONS IN RARE-GAS FLUORIDE (RgF) AND IN THE XENON-HALIDES

CONTENTS

A-4. Reference

The tables and figures in (A-4.1)-(A-4.27) are taken from the following sources:

(A-4.1)-(A-4.14):

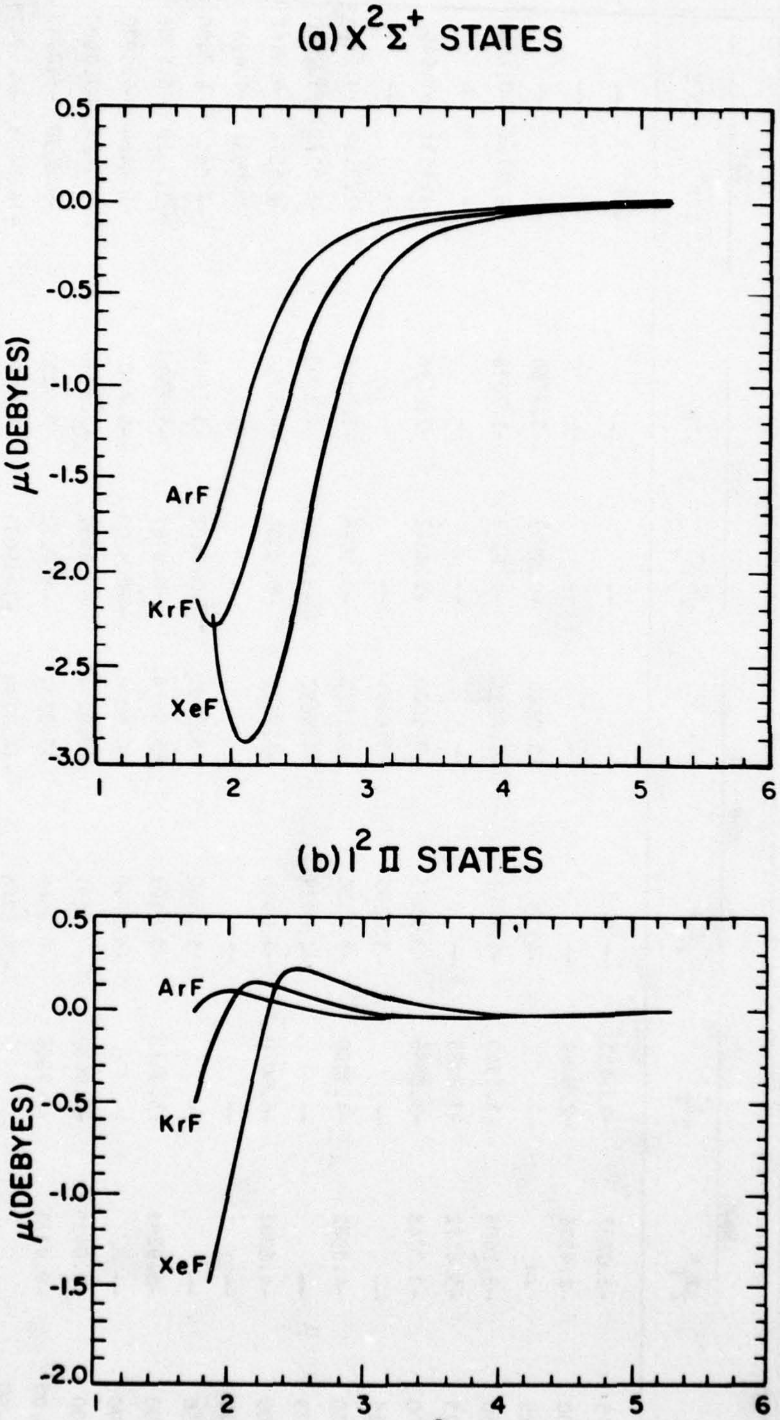
T. H. Dunning, Jr., and P. J. Hay, "The Low-Lying States of the Rare-Gas Fluorides," J. Chem. Phys. (to be published).

(A-4.15)-(A-4.27):

P. J. Hay and T. H. Dunning, Jr., "Electronic States of the Xenon Halides," J. Chem. Phys. (to be published).

Tabular Data. A-4.1. Calculated dipole moments of the covalent states of the rare gas fluorides. (The moments are in atomic units; the distances are in bohrs).

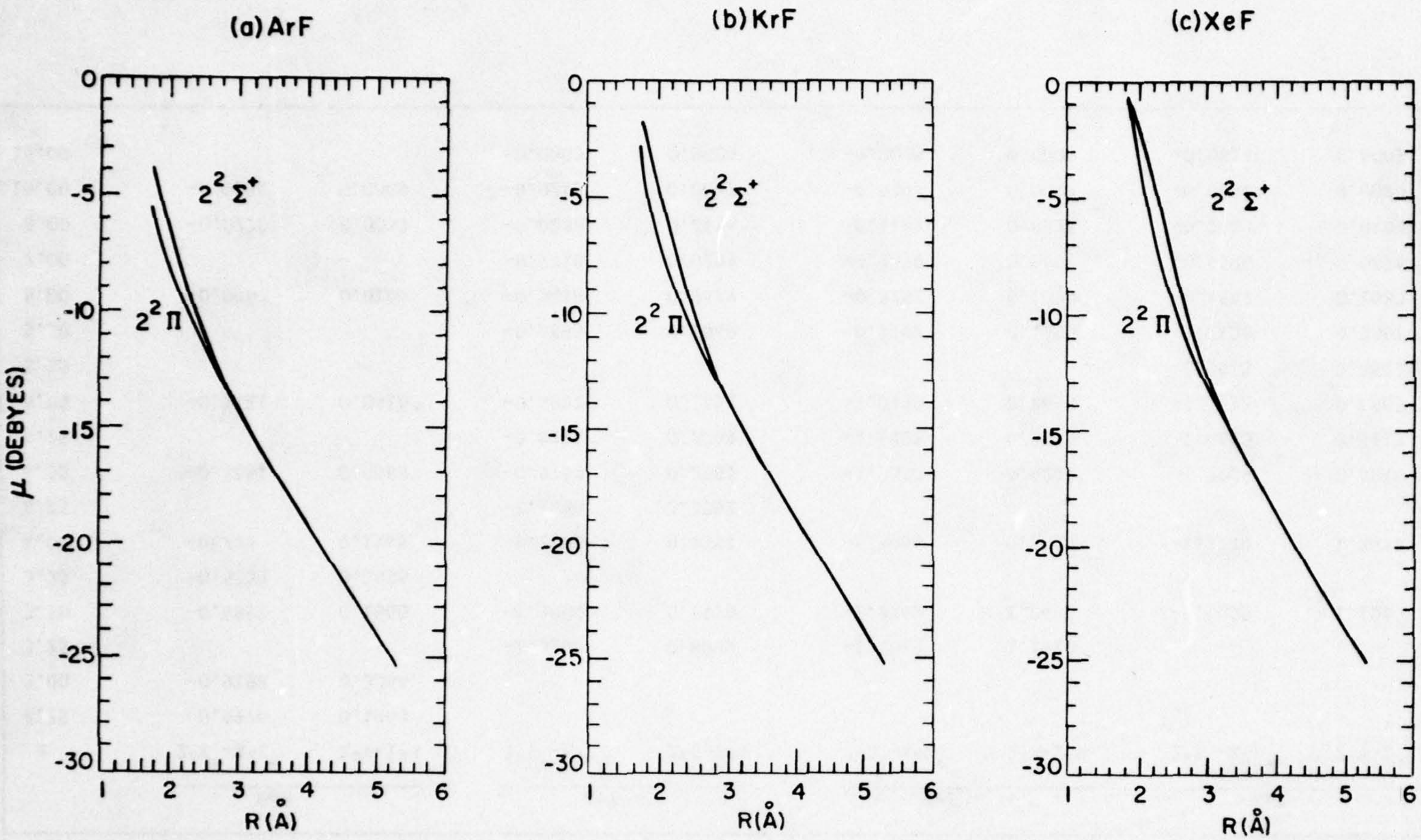
	NeF		ArF		KrF		XeF	
R	$X^2\Sigma^+$	$1^2\Pi$	$X^2\Sigma^+$	$1^2\Pi$	$X^2\Sigma^+$	$1^2\Pi$	$X^2\Sigma^+$	$1^2\Pi$
2.75	-0.4556	-0.1412	- -	- -	- -	--	- -	- -
3.00	-0.3264	-0.0888	- -	- -	- -	--	- -	- -
3.25	- -	- -	-0.7717	-0.0181	-0.8195	-0.2166	- -	- -
3.50	-0.1483	-0.0397	-0.6926	0.0301	-0.8965	-0.0863	-0.8787	-0.5771
3.75	-0.0987	-0.0289	- -	- -	- -	- -	- -	- -
4.00	-0.0669	-0.0219	-0.4231	0.0390	-0.7431	0.0576	-1.1357	-0.2153
4.25	- -	- -	-0.3042	0.0286	- -	- -	- -	- -
4.50	-0.0334	-0.0129	-0.2149	0.0173	-0.4411	0.0430	-0.9486	0.0703
4.75	- -	- -	-0.1526	0.0074	-0.3187	0.0390	-0.7610	0.0897
5.00	-0.0186	-0.0076	-0.1107	-0.0002	-0.2283	0.0253	-0.5708	0.0835
5.25	- -	- -	- -	- -	- -	- -	-0.4106	0.0691
5.50	- -	- -	-0.0638	-0.0090	-0.1225	0.0047	-0.2901	0.0534
6.00	-0.0087	-0.0048	-0.0416	-0.0122	-0.0739	-0.0066	-0.1480	0.0269
7.00	- -	- -	-0.0240	-0.0134	-0.0381	-0.0148	-0.0545	-0.0010
8.00	-0.0028	-0.0019	-0.0151	-0.0102	-0.0245	-0.0140	-0.0311	-0.0093
10.00	- -	- -	-0.0031	-0.0014	-0.0064	-0.0029	-0.0113	-0.0047
15.00	-0.0004	-0.0001	-0.0002	0.0001	-0.0005	0.0002	-0.0009	0.0003



Graphical Data. A-4.2. Calculated dipole moments for the covalent states of ArF, KrF and XeF.

Tabular A-4-3. Calculated dipole moments of the ionic states of the rare gas fluorides. (The moments are in atomic units; the distances are in bohrs).

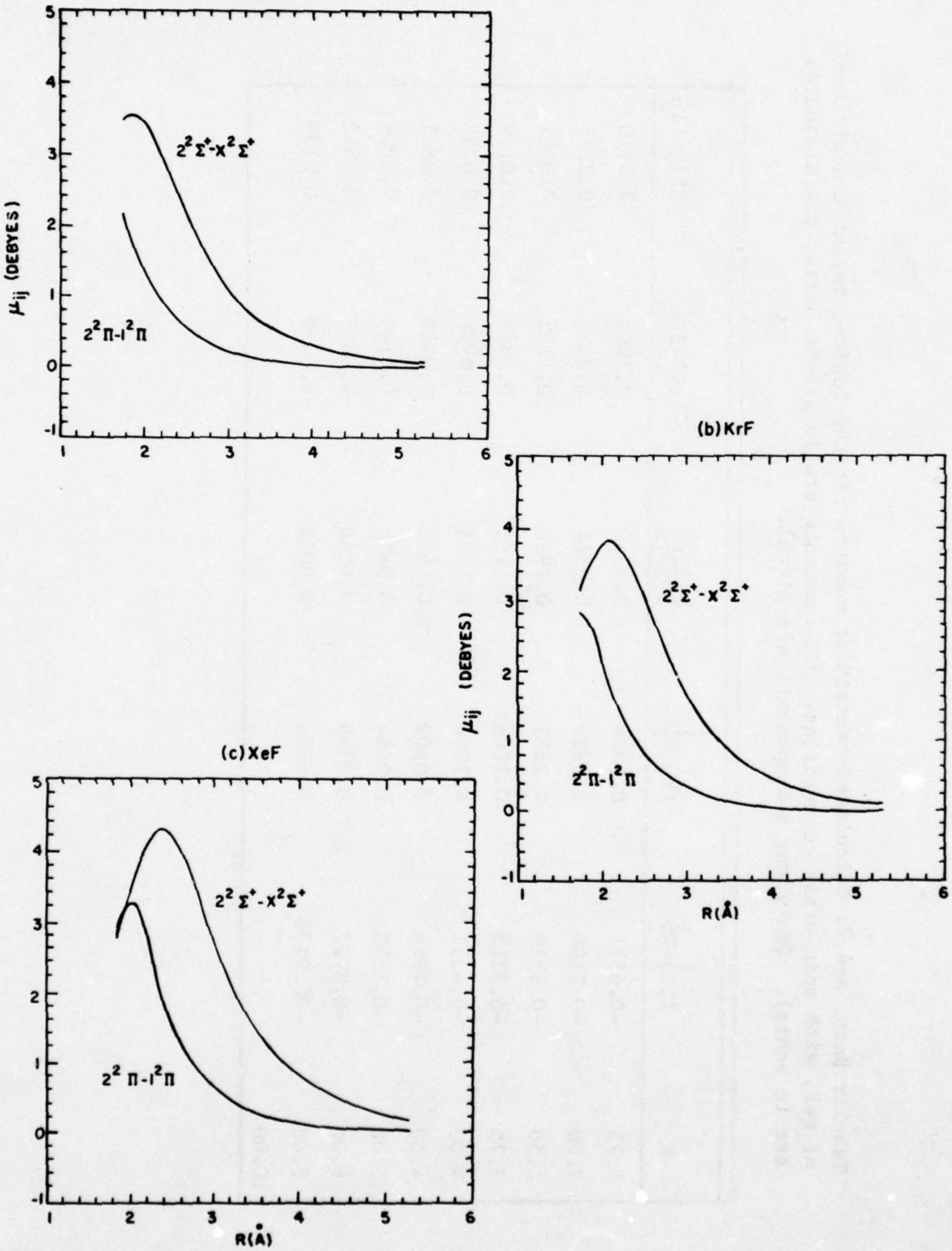
	NeF		ArF		KrF		XeF	
R	$2^2\Sigma^+$	$2^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$	$2^2\Sigma^+$	$2^2\Pi$
2.75	-2.0297	-2.5951	--	--	--	--	--	--
3.00	-2.4396	-2.8499	--	--	--	--	--	--
3.25	--	- -	-4129	-2.0840	-0.6199	-0.9768	--	--
3.50	-3.1605	-3.3540	-1.9817	-2.6591	-1.1378	-1.7878	-0.2744	-0.1436
3.75	-3.4771	-3.6085	--	--	--	--	--	--
4.00	-3.7748	-3.8656	-3.0535	-3.5000	-2.2842	-3.0096	-1.1531	-1.8497
4.25	--	--	-3.5185	-3.8435	--	--	--	--
4.50	-4.3382	-4.3850	-3.9320	-4.1622	-3.3898	-3.8448	-2.3192	-3.2185
4.75	--	--	-4.3029	-4.4652	-3.8706	-4.1998	-2.9375	-3.7000
5.00	-4.8802	-4.9070	-4.6416	-4.7572	-4.3000	-4.5329	-3.5274	-4.1168
5.25	--	--	--	--	--	--	-4.0634	-4.4953
5.50	--	--	-5.2560	-5.3181	-5.0401	-5.1560	-4.5407	-4.8490
6.00	-5.9294	-5.9413	-5.8209	-5.8576	-5.6787	-5.7396	-5.3516	-5.5069
7.00	--	--	-6.8849	-6.9028	-6.8100	-6.8327	-6.6484	-6.6970
8.00	-7.9639	-7.9689	-7.9155	-7.9274	-7.8657	-7.8788	-7.7668	-7.7900
10.00	-9.9771	-9.9800	-9.9469	-9.9531	-9.9172	-9.9233	-9.8630	-9.8743
15.00			-14.9766	-14.9790	-14.9635	-14.9657	-14.9403	-14 .9445



Graphical Data. A-4.4. Calculated dipole moments for the ionic states of ArF, KrF and XeF.

Tabular Data. A-4.5. Calculated transition moments for the ionic-covalent transitions of the rare gas fluorides. (The moments are in atomic units; the distances are in bohrs).

	NeF		ArF		KrF		XeF	
R	$2^2\Sigma^+-X^2\Sigma^+$	$2^2\Pi-1^2\Pi$	$2^2\Sigma^+-X^2\Sigma^+$	$2^2\Pi-1^2\Pi$	$2^2\Sigma^+-X^2\Sigma^+$	$2^2\Pi-1^2\Pi$	$2^2\Sigma^+-X^2\Sigma^+$	$2^2\Pi-1^2\Pi$
2.75	-0.9974	0.4343						
3.00	-0.9198	0.3364						
3.25			-1.3500	0.8892	-1.2019	1.1110		
3.50	-0.6892	0.1960	-1.3990	0.7159	-1.3742	1.0492	-1.1055	1.1088
3.75	-0.5752	0.1496						
4.00	-04745	0.1145	-1.2656	0.4352	-1.5066	0.6923	-1.5140	1.2452
4.25			-1.1266	0.3392				
4.50	-0.3181	0.0683	-0.9753	0.2655	-1.3332	0.4241	-1.7009	0.8014
4.75			-0.8294	0.2089	-1.1824	0.3341	-1.6650	0.6219
5.00	-0.2121	0.0416	-0.6982	0.1652	-1.0239	0.2648	-1.5513	0.4863
5.25							-1.3913	0.3842
5.50			-0.4885	0.1049	-0.7392	0.1690	-1.2156	0.3061
6.00	-0.0963	0.0160	-0.3418	0.0678	-0.5251	0.1099	-0.8897	0.1982
7.00			-0.1719	0.0295	-0.2679	0.0484	-0.4596	0.0874
8.00	-0.0220	0.0032	-0.0888	0.0134	-0.1402	0.0222	-0.2413	0.0402
10.00	-0.0054	0.0009	-0.0242	0.0027	-0.0397	0.0047	-0.0694	0.0088
15.00			-0.0003	0.0000	-0.0005	0.0000	-0.0013	0.0001



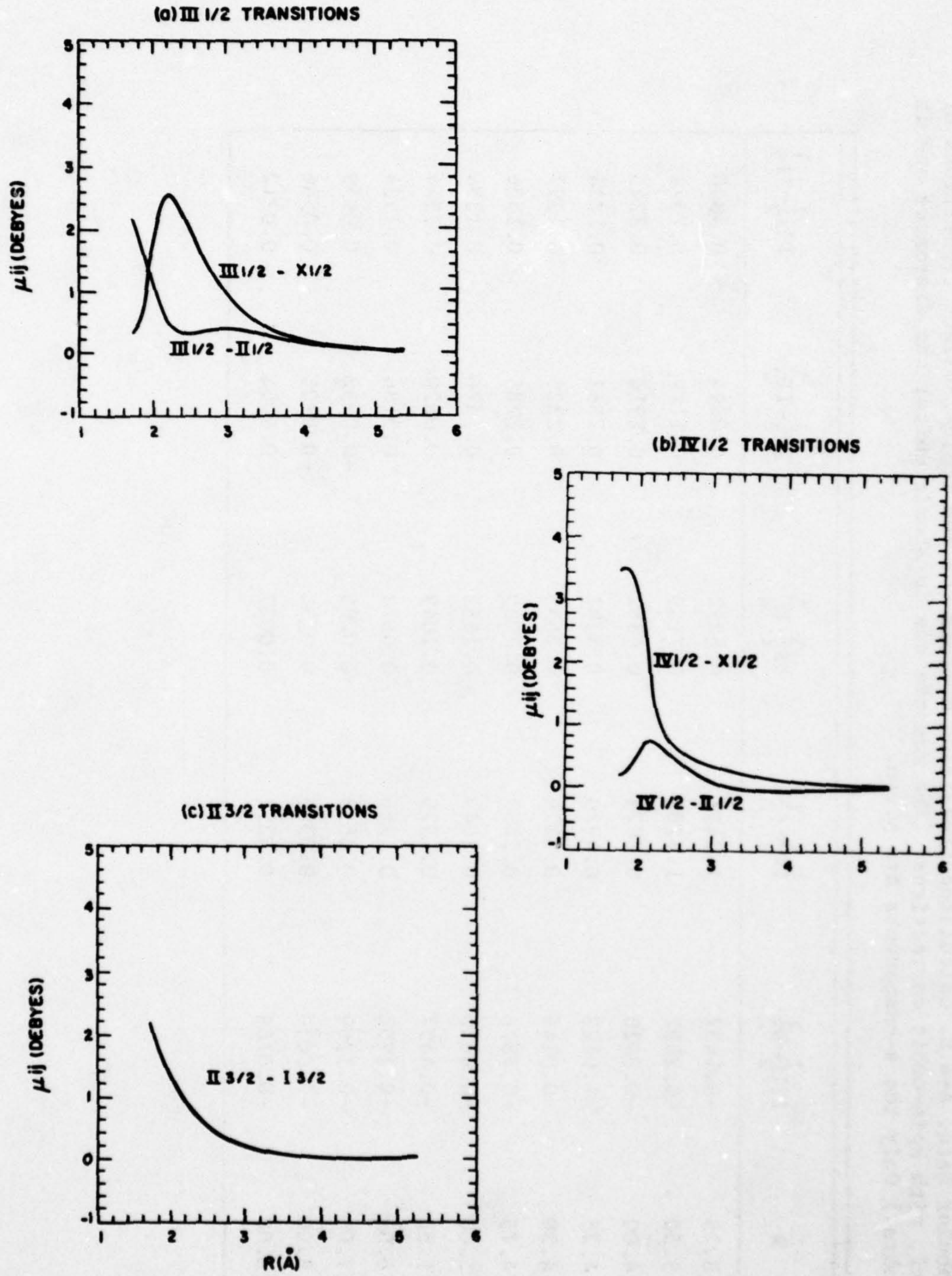
Graphical Data. A-4.6. Calculated transition moments for the ionic-covalent transitions in ArF, KrF and XeF.

Tabular Data. A-4.7. Calculated transition moments for the ionic-covalent transitions of NeF, with spin-orbit corrections. (The moments are in atomic units; the distances are in bohrs). (Only the z-components are given).

R	$III\frac{1}{2}-X\frac{1}{2}$	$IV\frac{1}{2}-X\frac{1}{2}$	$II\frac{3}{2}-I\frac{3}{2}$	$IV\frac{1}{2}-II\frac{1}{2}$	$III\frac{1}{2}-II\frac{1}{2}$
2.75	-0.6571	0.6824	0.4343	0.2969	0.3170
3.00	-0.7106	0.5839	0.3364	0.2532	0.2217
3.50	-0.6519	0.2221	0.1960	0.1782	0.0851
3.75	-0.5513	0.1605	0.1496	0.1349	0.0729
4.00	-0.4551	0.1266	0.1145	0.0992	0.0728
4.50	-0.2966	0.0909	0.0683	0.0468	0.0861
5.00	-0.1835	0.0684	0.0416	0.0144	0.0904
6.00	-0.0727	0.0359	0.0160	-0.0055	0.0541
8.00	-00.0158	0.0104	0.0032	-0.0039	0.0130
10.00					

Tabular Data. A-4.8. Calculated transition moments for the ionic-covalent transitions of ArF, with spin-orbit corrections. (The moments are in atomic units; the distances are in bohrs.) Only the z-components are given.

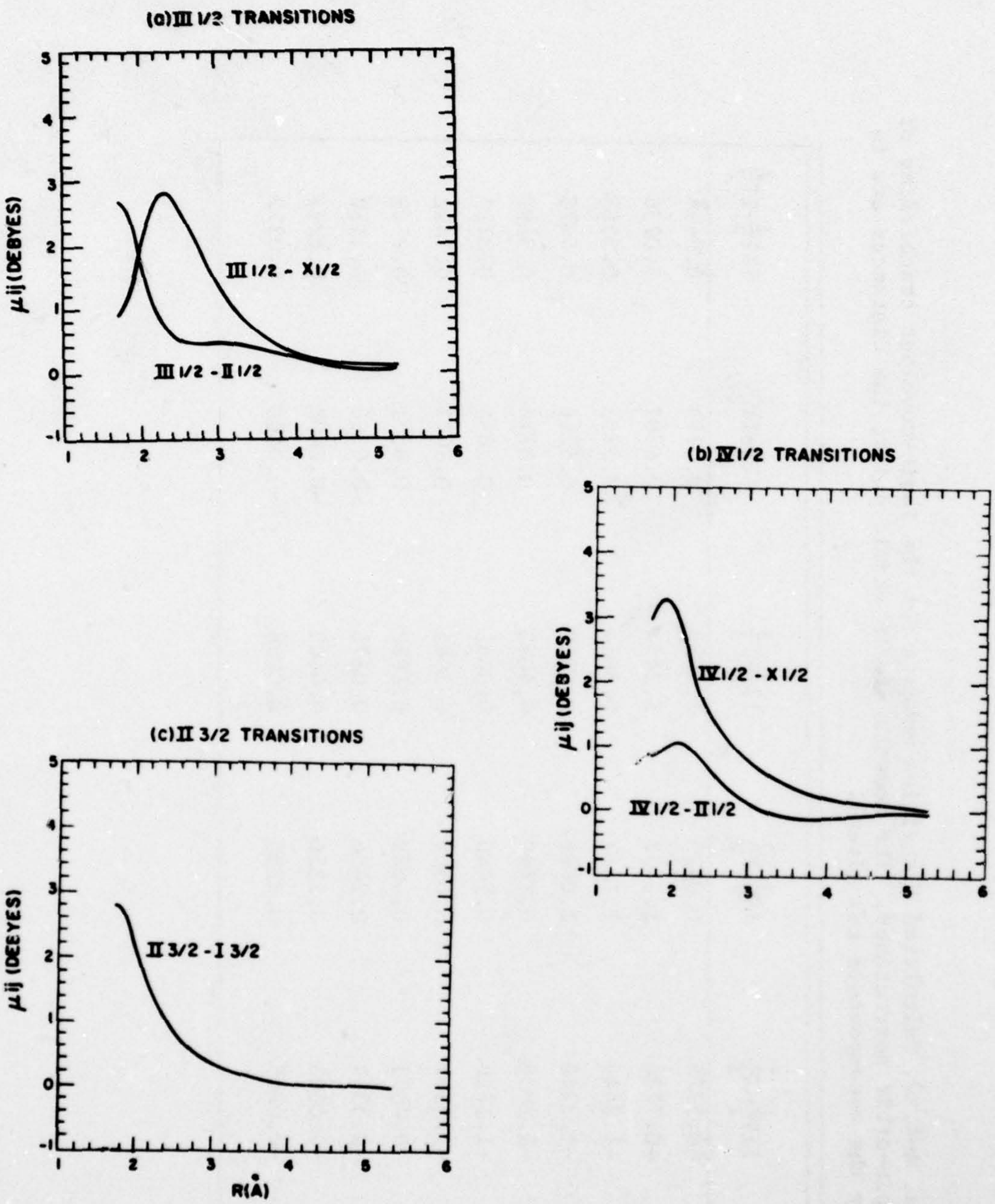
R	$III\frac{1}{2}-X\frac{1}{2}$	$IV\frac{1}{2}-X\frac{1}{2}$	$II\frac{3}{2}-I\frac{3}{2}$	$IV\frac{1}{2}-II\frac{1}{2}$	$III\frac{1}{2}-II\frac{1}{2}$
3.25	-0.1437	1.3423	0.8892	0.0894	0.8848
3.50	-0.2392	1.3784	0.7159	0.1119	0.7072
4.00	-0.9020	0.8873	0.4352	0.2914	0.3245
4.25	-1.0123	0.4929	0.3392	0.2882	0.1834
4.50	-0.9169	0.3279	0.2655	0.2325	0.1397
4.75	-0.7876	0.2497	0.2089	0.1786	0.1306
5.00	-0.6610	0.2049	0.1652	0.1326	0.1354
5.50	-0.4457	0.1529	0.1049	0.0620	0.1544
6.00	-0.2902	0.1166	0.0678	0.0186	0.1524
7.00	-0.1299	0.0653	0.0295	-0.0092	0.0959
8.00	-0.0636	0.0366	0.0134	-0.0105	0.0506
10.00	-0.0109	0.0211	0.0027	0.0094	0.0212



Graphical Data. A-4.9. Calculated transition moments for the ionic-covalent transitions of ArF, with spin-orbit corrections.

Tabular Data. A-4.10. Calculated transition moments for the ionic-covalent transitions of XeF, with spin-orbit corrections. (The moments are in atomic units; the distances are in bohrs).(Only the z-components are given).

R	$III\frac{1}{2}-X\frac{1}{2}$	$IV\frac{1}{2}-X\frac{1}{2}$	$II\frac{3}{2}-I\frac{3}{2}$	$IV\frac{1}{2}-II\frac{1}{2}$	$III\frac{1}{2}-II\frac{1}{2}$
3.50	-0.5776	0.9425	1.1088	0.5794	0.9454
4.00	-0.7706	1.3032	1.2452	0.6307	1.0736
4.50	-1.2546	1.1481	0.8014	0.5751	0.5588
4.75	-1.3240	1.0088	0.6219	0.4716	0.4075
5.00	-1.2838	0.8690	0.4863	0.3716	0.3192
5.25	-1.1729	0.7440	0.3842	0.2834	0.2717
5.50	-1.0301	0.6365	0.3061	0.2073	0.2492
6.00	-0.7393	0.4669	0.1982	0.0851	0.2429
7.00	-0.3344	0.2436	0.0874	-0.0366	0.2152
8.00	-0.0603	0.1256	0.0402	-0.0408	0.1293
10.00	-0.0445	0.0356	0.0088	-0.0160	0.0372



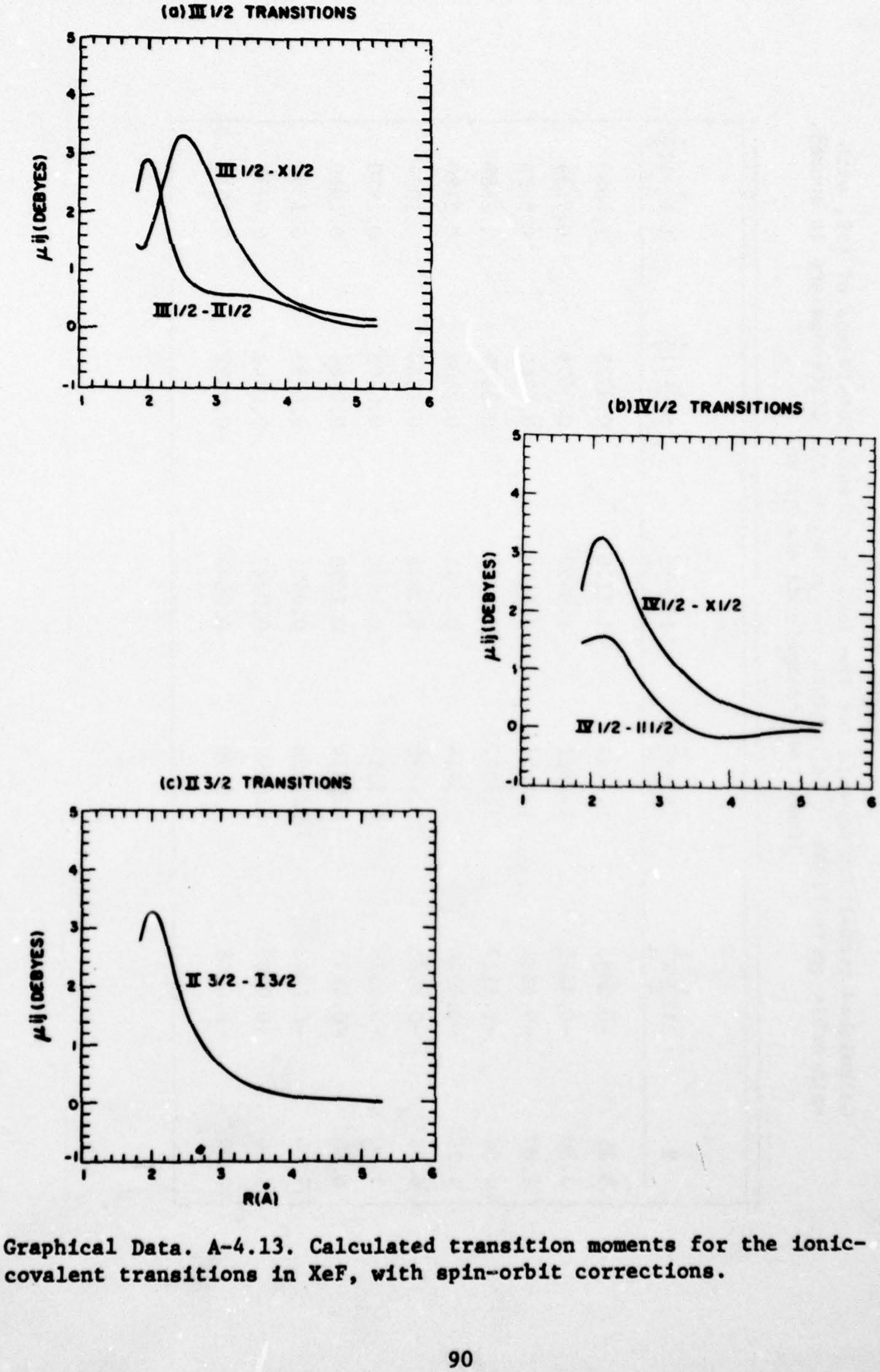
Graphical Data A-4.11.

Calculated transition moments for the ionic-covalent transitions in KrF, with spin-orbit corrections.

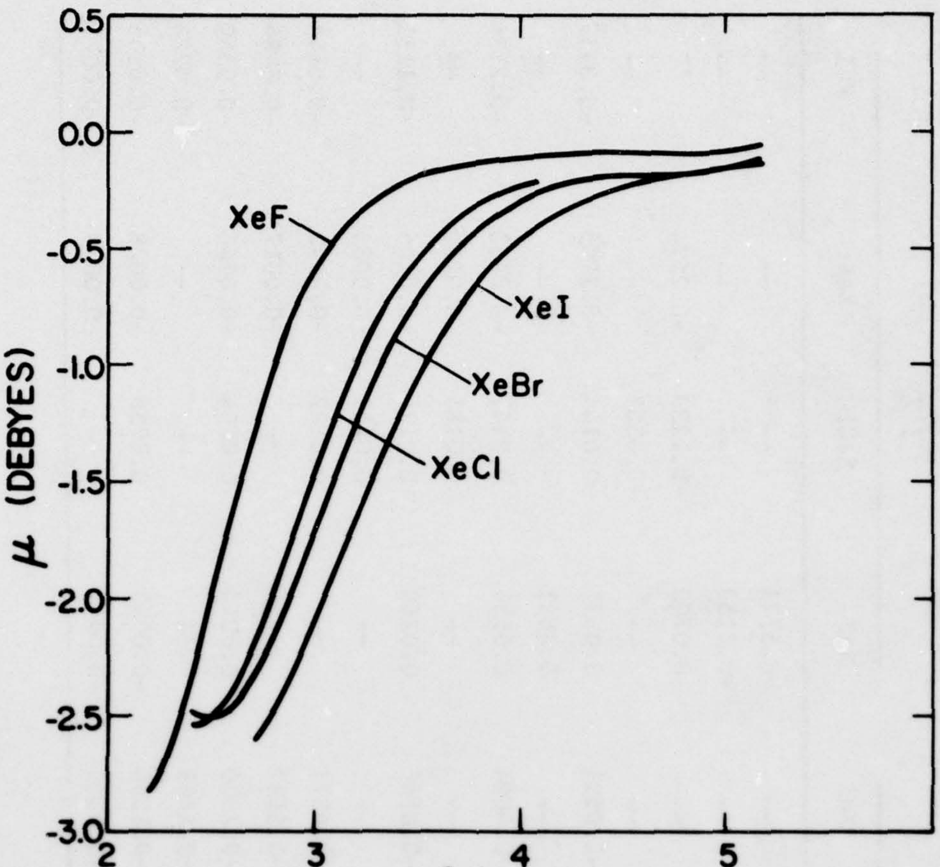
Tabular Data A-4.12.

Calculated transition moments for the ionic-covalent transitions of KrF, with spin-orbit corrections. (The moments are in units; the distances are in bohrs). (Only the z-components are given)

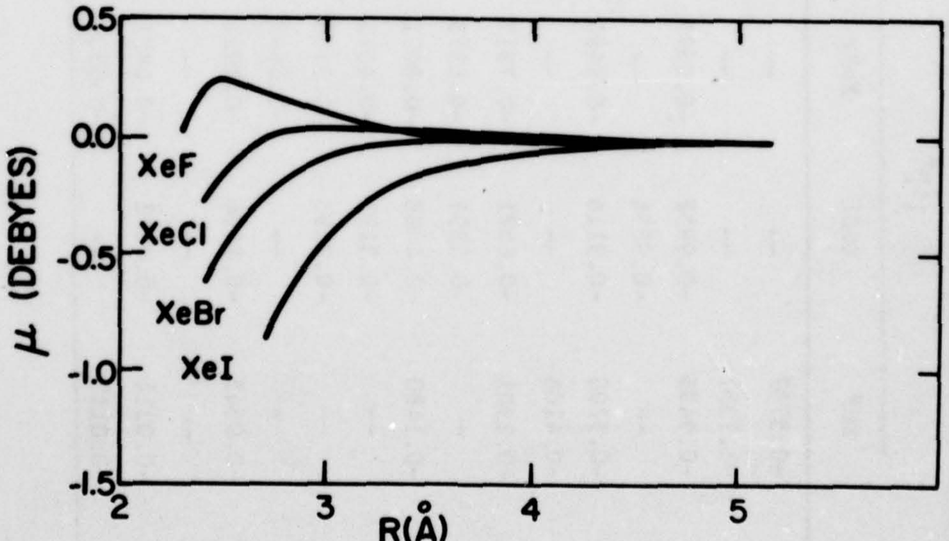
R	$III\frac{1}{2}-X\frac{1}{2}$	$IV\frac{1}{2}-X\frac{1}{2}$	$II\frac{3}{2}-I\frac{3}{2}$	$IV\frac{1}{2}-II\frac{1}{2}$	$III\frac{1}{2}-II\frac{1}{2}$
3.25	-0.3661	1.1448	1.1110	0.3375	1.0585
3.50	-0.4841	1.2861	1.0492	0.3656	0.9834
4.00	-0.9581	1.1625	0.6923	0.4264	0.5458
4.50	-1.1117	0.7347	0.4241	0.3309	0.2689
4.75	-1.0220	0.5914	0.3341	0.2604	0.2180
5.00	-0.8965	0.4880	0.2648	0.1960	0.1954
5.50	-0.6376	0.3517	0.1690	0.0905	0.1910
6.00	-0.4292	0.2554	0.1099	0.0184	0.1950
7.00	-0.1900	0.1326	0.0484	-0.0293	0.1399
8.00	-0.0935	0.0697	0.0222	-0.0243	0.0771
10.00	-0.0258	0.0199	0.0047	-0.0092	0.0213



Graphical Data. A-4.13. Calculated transition moments for the ionic-covalent transitions in XeF, with spin-orbit corrections.



(a) Dipole moments for the $1^2\Sigma^+$ state of the xenon halides.



(b) Dipole moments for the $1^2\Pi$ state of the xenon halides.

Graphical Data.A-4.14.

Tabular Data. A-4.15. Calculated dipole moments for the covalent states of the xenon halides without spin-orbit coupling corrections. (All quantities are in atomic units).

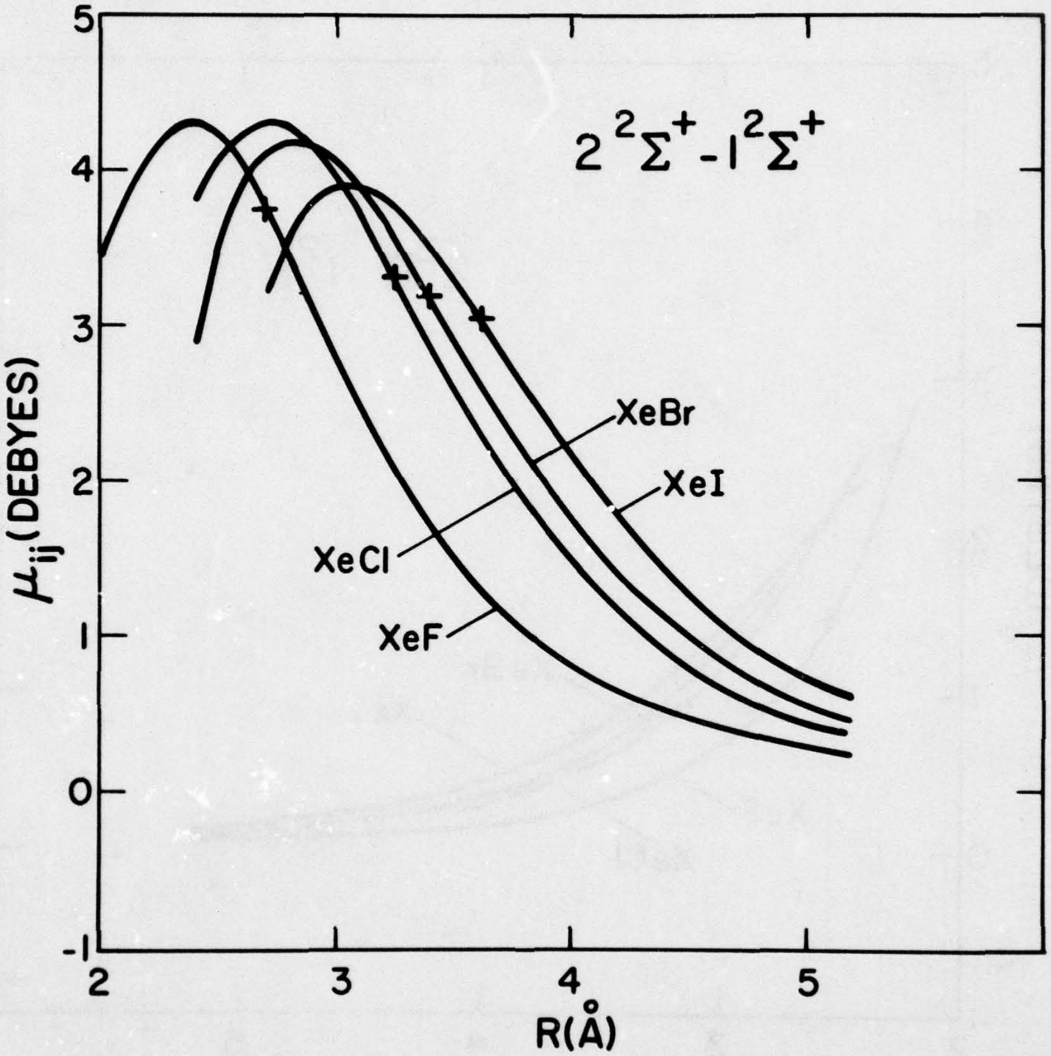
	$1^2\Sigma^+$				$1^2\Pi$			
	XeF	XeCl	XeBr	XeI	XeF	XeCl	XeBr	XeI
3.50	-0.8787	--	--	--	-0.5771	--	--	--
4.00	-1.1357	--	--	--	-0.2153	--	--	--
4.50	-0.9486	-0.9952	-0.9677	--	0.0703	-0.1233	-0.2674	--
4.75	--	-0.9854	--	--	--	-0.0565	--	--
5.00	-0.5708	-0.9116	-0.9490	-1.0511	0.0835	-0.0144	-0.1203	-0.3957
5.25	-0.4106	--	--	--	0.0691	--	--	--
5.50	-0.2901	-0.6591	-0.7517	-0.9004	0.0534	0.0162	-0.0453	-0.2134
5.75	--	-0.5259	-0.6273	--	--	0.0185	-0.0269	--
6.00	-0.1480	-0.4088	-0.5071	-0.6746	0.0269	0.0174	-0.0155	-0.1151
6.25	--	-0.3133	-0.4011	--	--	0.0151	-0.0085	--
6.50	--	-0.2395	-0.3135	-0.4571	--	0.0122	-0.0042	-0.0648
6.75	--	--	-0.2443	-0.3682	--	--	-0.0017	-0.0494
7.00	-0.0545	-0.1434	-0.1911	-0.2950	-0.0010	0.0064	-0.0006	-0.0380
7.50	--	--	--	-0.1899	--	--	--	-0.0226
8.00	-0.0311	-0.0642	-0.0821	-0.1254	-0.0093	0.0036	-0.0028	-0.0135
10.00	-0.0113	--	-0.0304	-0.0392	-0.0047	--	-0.0079	-0.0071

Tabular Data. A-4.16. Calculated dipole moments for the ionic states of the xenon halides without spin-orbit coupling corrections. (All quantities are in atomic units).

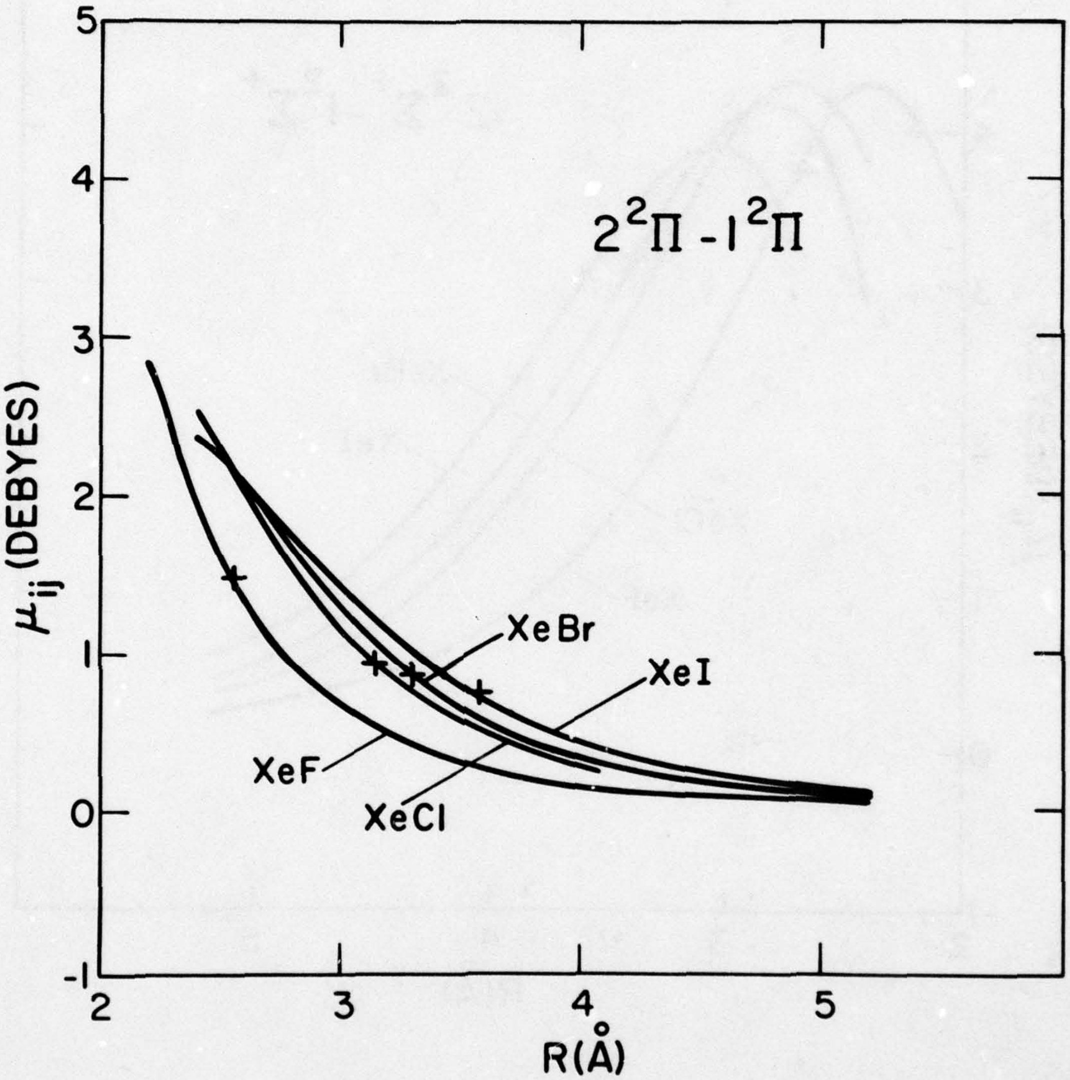
R	$2^2\Sigma^+$				$2^2\Pi$			
	XeF	XeCl	XeBr	XeI	XeF	XeCl	XeBr	XeI
3.50	-0.2744	--	--	--	-0.1436	--	--	--
4.00	-1.1531	--	--	--	-1.8497	--	--	--
4.50	-2.3192	-1.5588	-1.5921	--	-3.2185	-2.4287	-2.2722	--
4.75	--	-2.0731	--	--	--	-3.0218	--	--
5.00	-3.5274	-2.6175	-2.4027	-1.9476	-4.1168	-3.5399	-3.3408	-3.0928
5.25	-4.0634	--	--	--	-4.4953	--	--	--
5.50	-4.5407	-3.7149	-3.4364	-2.8479	-4.8490	-4.4092	-4.2222	-3.9167
5.75	--	-4.2325	-3.9466	--	--	-4.7903	-4.6112	--
6.00	-5.3516	-4.7155	-4.4352	-3.8494	-5.5069	-5.1496	-4.9774	-4.6675
6.25	--	-5.1622	-4.8966	--	--	-5.4933	-5.3279	--
6.50	--	-5.5756	-5.3297	-4.7998	--	-5.8252	-5.6672	-5.3623
6.75	--	--	-5.7364	-5.2402	--	--	-5.9981	-5.6968
7.00	-6.6484	-6.3210	-6.1197	-5.6577	-6.6970	-6.4613	-6.3217	-6.0259
7.50	--	--	--	-6.4338	--	--	--	-6.6715
8.00	-7.7667	-7.5953	-7.4731	-7.1457	-7.7900	-7.6420	-7.5429	-7.2992
10.00	-9.8629	--	-9.7285	-9.5723	-9.8743	--	-9.7435	-9.6053

Tabular Data. A-4.17. Calculated transition moments for the ionic-covalent transitions of the xenon halides without spin-orbit corrections. (All quantities are in atomic units).

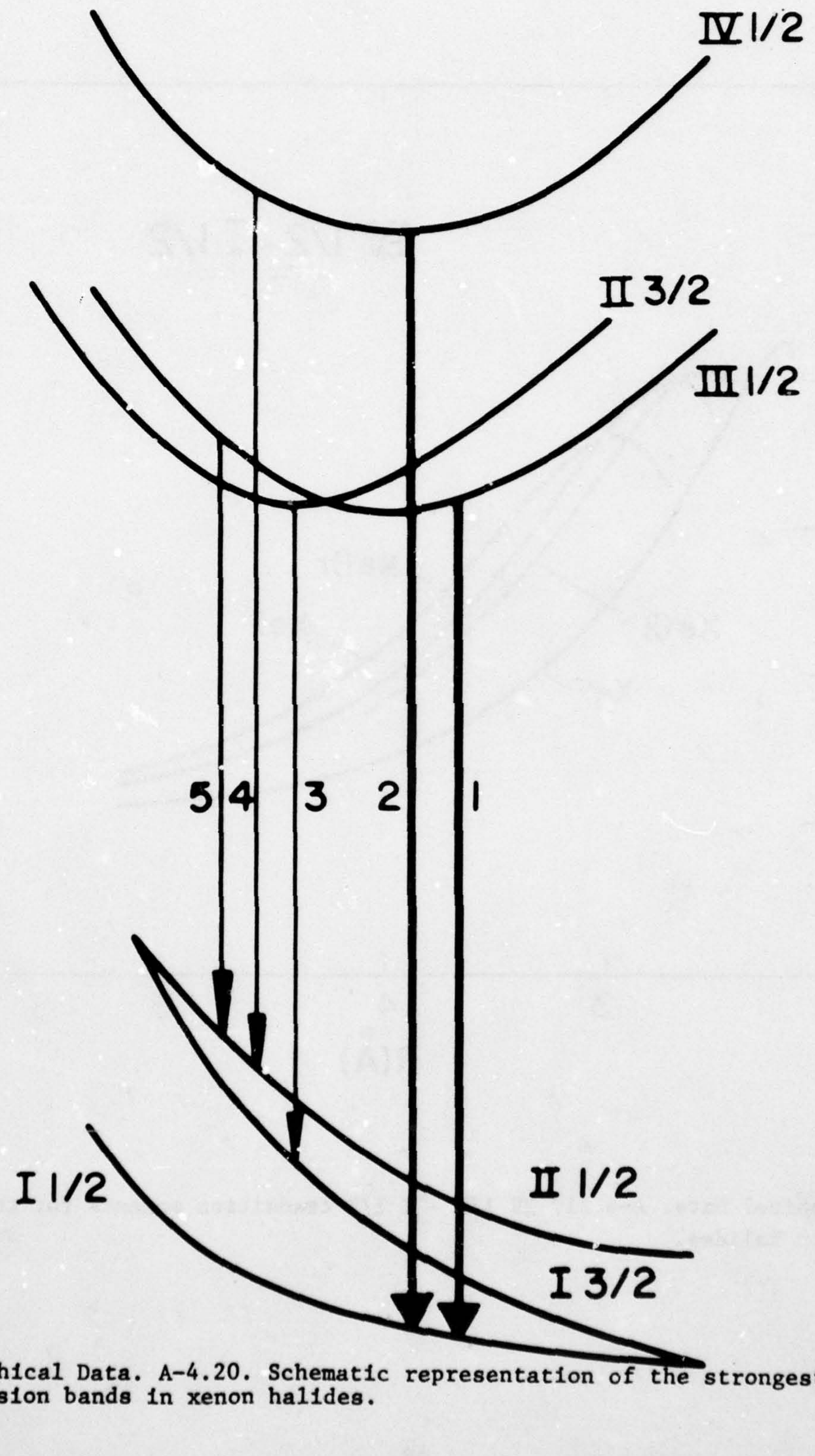
	$2^2\Sigma^+ - 1^2\Sigma^+$				$2^2\Pi - 1^2\Pi$			
R	XeF	XeCl	XeBr	XeI	XeF	XeCl	XeBr	XeI
3.50	-1.1055	--	--	--	1.1088	--	--	--
4.00	-1.5140	--	--	--	1.2452	--	--	--
4.50	-1.7009	-1.4684	-1.0758	--	0.8014	1.0090	0.9388	--
4.75	-1.6650	-1.6151	--	--	0.6219	0.8928	--	--
5.00	-1.5513	-1.6887	-1.5818	-1.1405	0.4863	0.7595	0.7893	0.7494
5.25	-1.3913	--	--	--	0.3842	--	--	--
5.50	-1.2156	-1.6343	-1.6358	-1.5036	0.3061	0.5240	0.5780	0.6247
5.75	--	-1.5285	-1.5767	--	--	0.4321	0.4857	--
6.00	-1.8897	-1.3929	-1.4769	-1.5168	0.1982	0.3560	0.4061	0.4713
6.25	--	-1.2445	-1.3519	--	--	0.2935	0.3387	--
6.50	--	-1.0961	-1.2153	-1.3555	--	0.2421	0.2822	0.3418
6.75	--	--	-1.0780	-1.2424	--	--	0.2351	0.2891
7.00	-0.4596	-0.8277	-0.9469	-1.1220	0.0874	0.1655	0.1958	0.2440
7.50	--	--	--	-0.8870	--	--	--	0.1732
8.00	-0.2413	-0.4525	-0.5359	-0.6830	0.0402	0.0787	0.0951	0.1226
10.00	-0.0694	--	-0.1648	-0.2191	0.0088	--	0.0242	0.0316



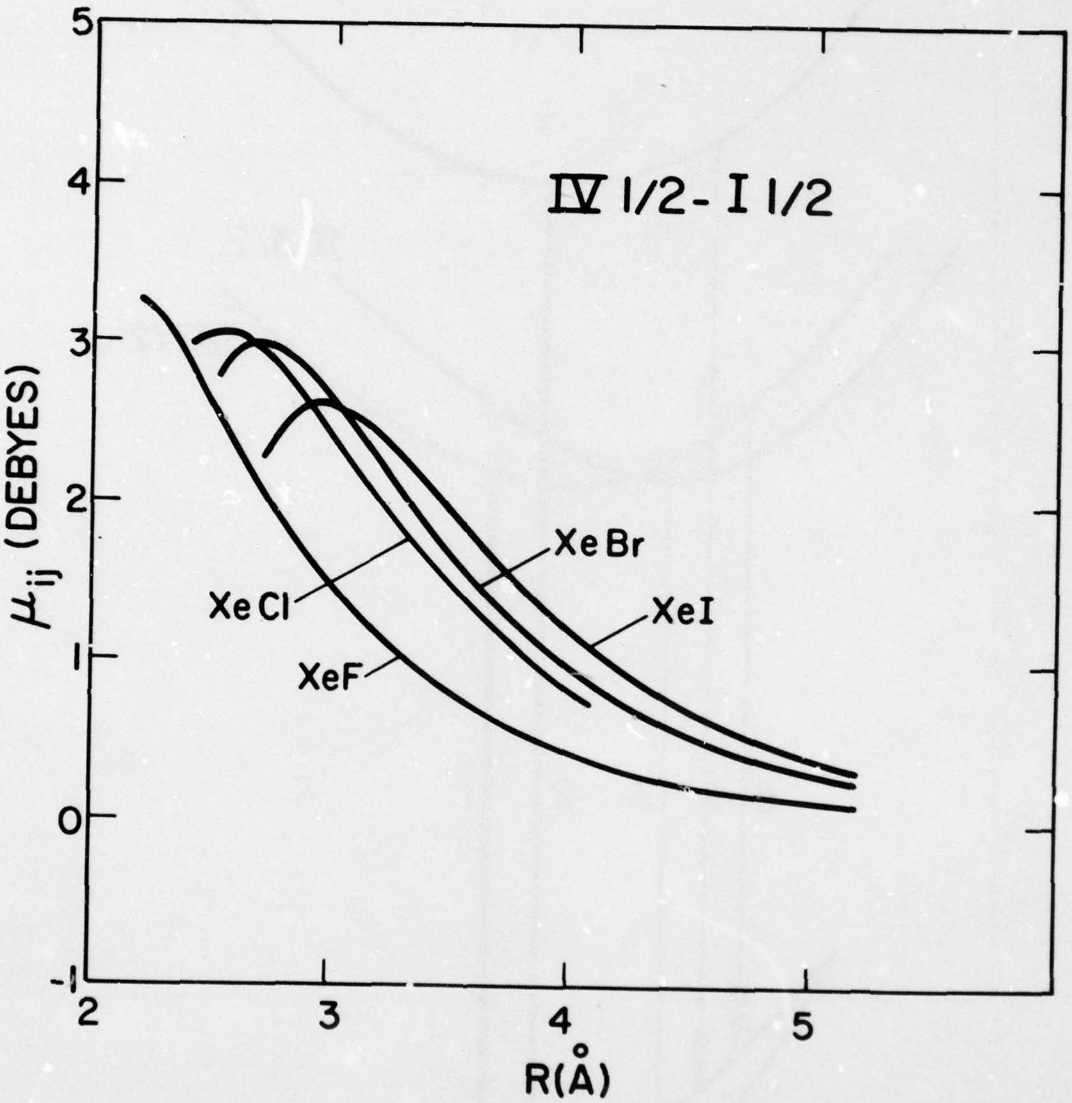
Graphical Data. A-4.18. $2^2\Sigma^+ - 1^2\Sigma^+$ transition moments for the xenon halides.



Graphical Data. A-4.19. $2^2\pi$ - $1^2\pi$ transition moments for the xenon halides.



Graphical Data. A-4.20. Schematic representation of the strongest emission bands in xenon halides.



Graphical Data. A-4.21. IV 1/2 - I 1/2 transition moments for the xenon halides.

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COMPILATION OF DATA RELEVANT TO RARE GAS-RARE GAS AND RARE GAS---ETC(U)
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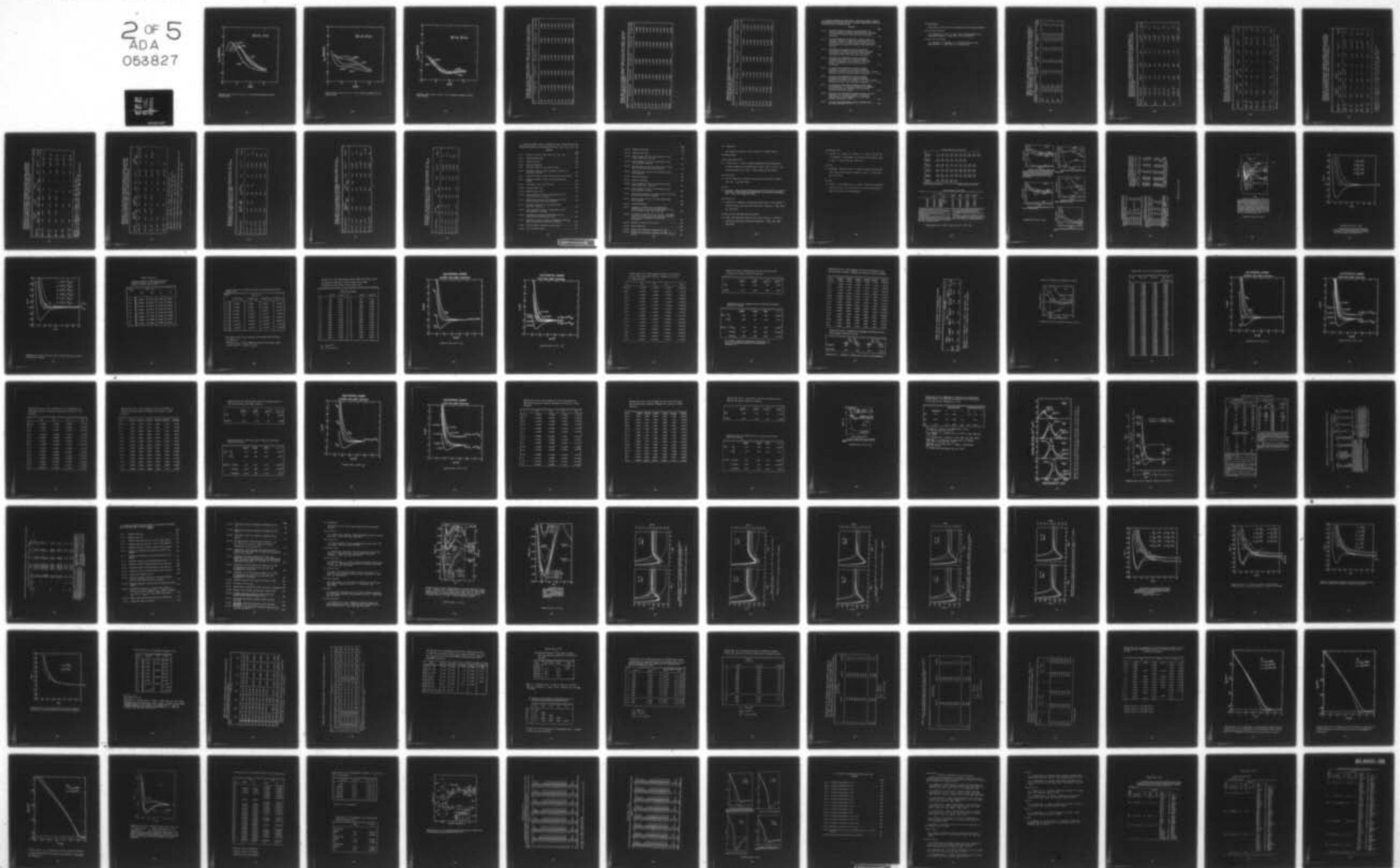
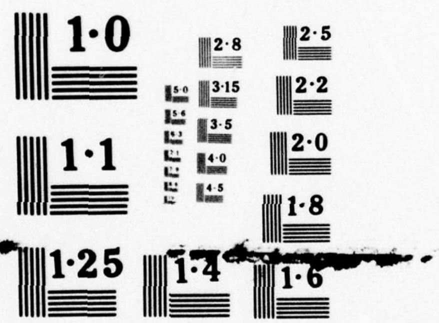
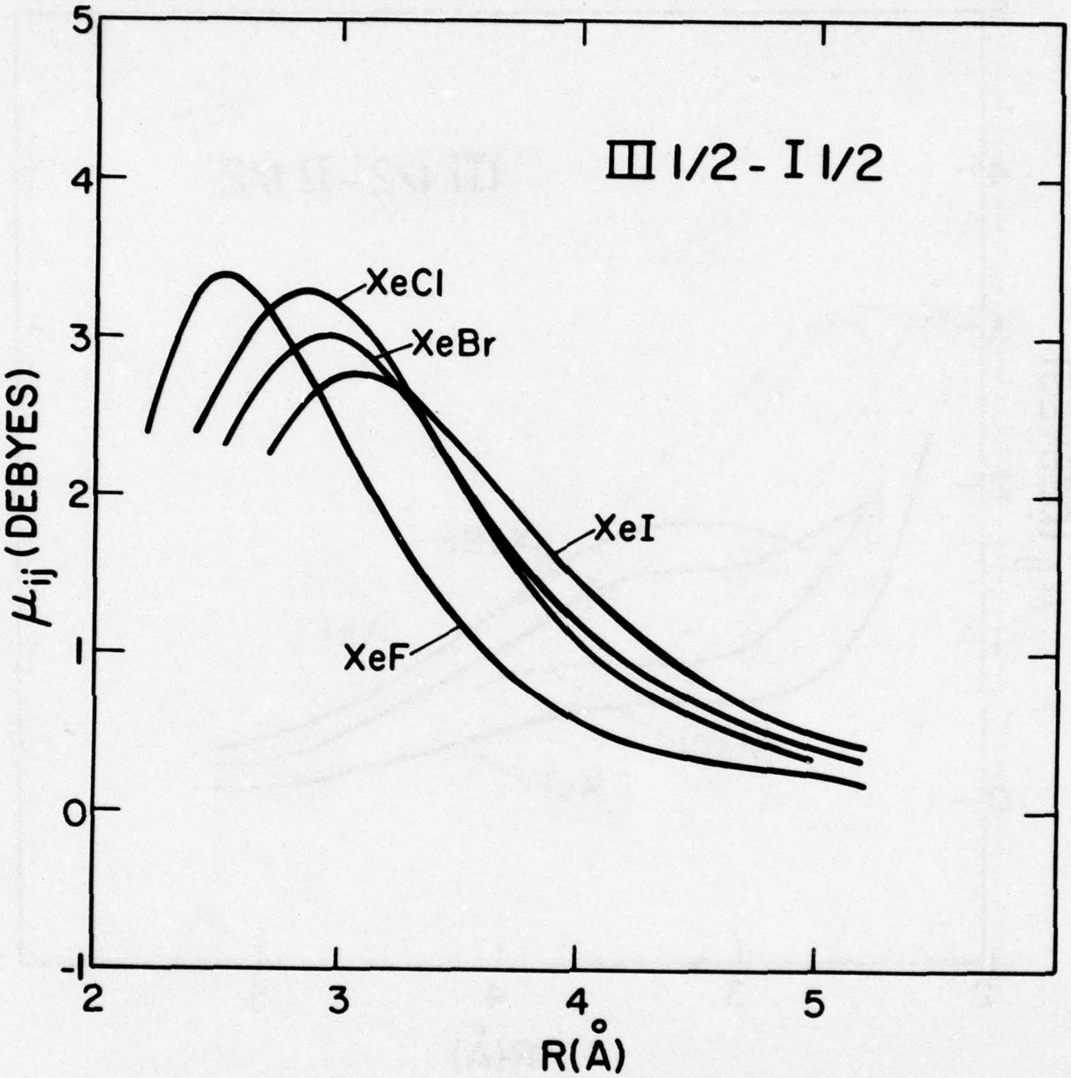
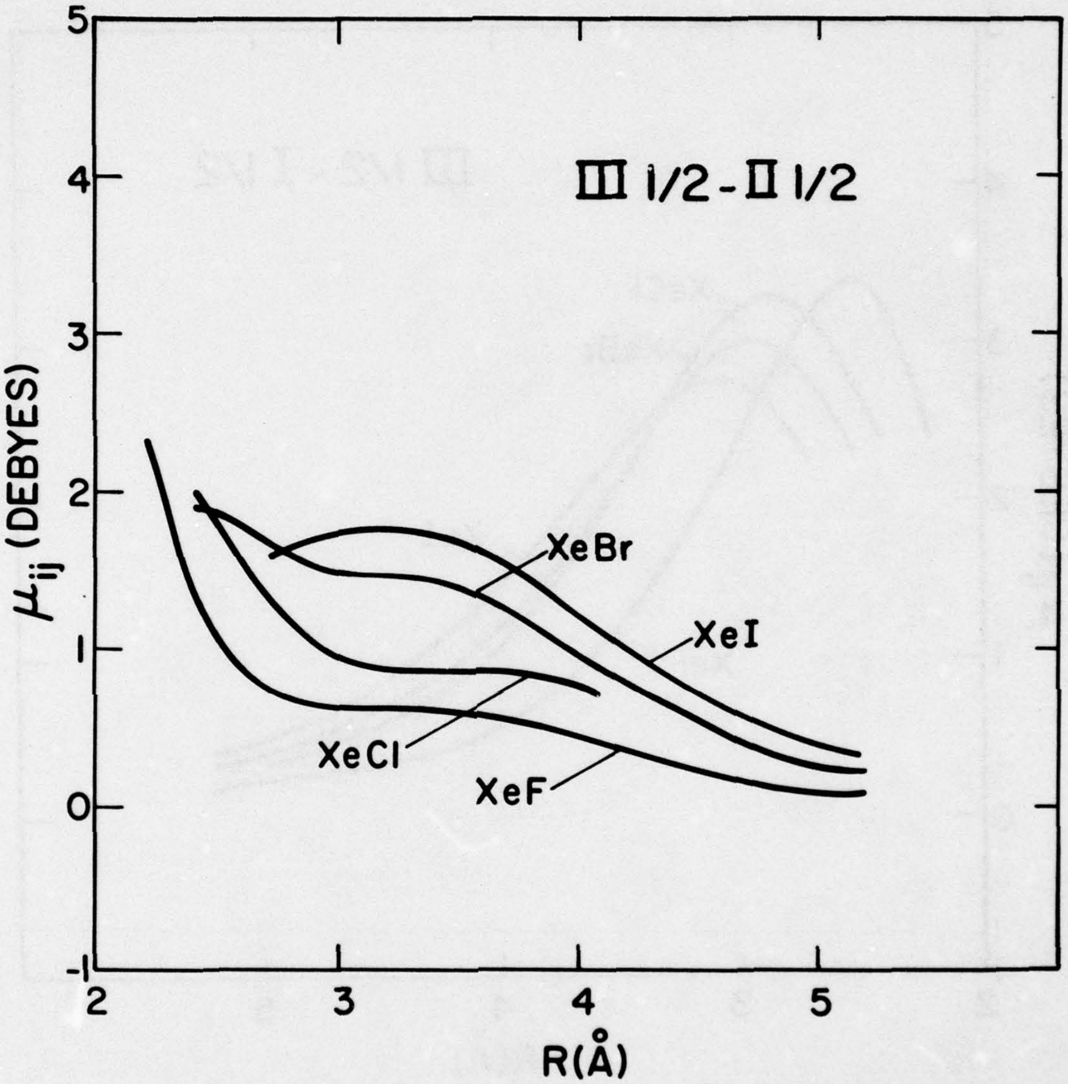


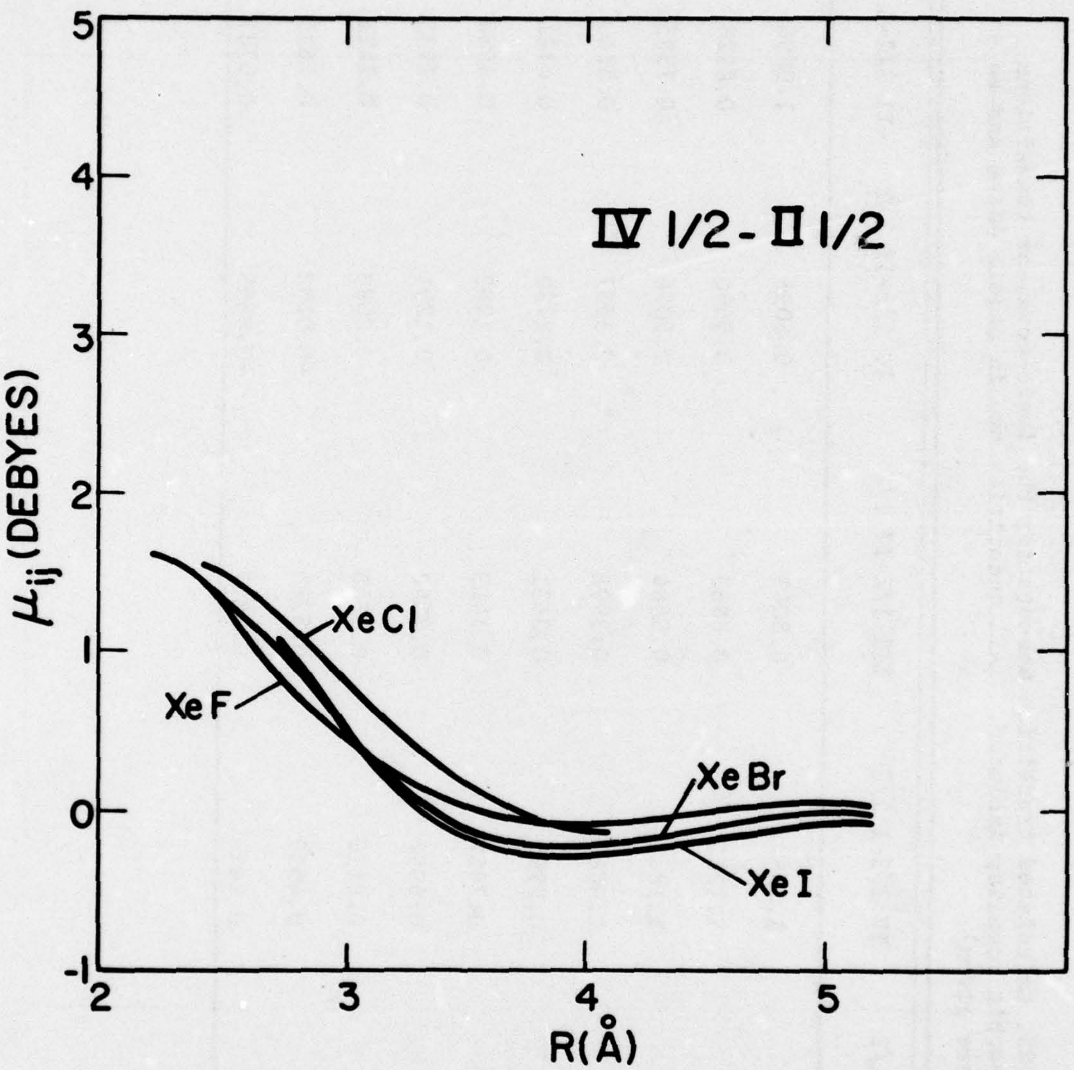




Graphical Data. A-4.22. III 1/2 - I 1/2 transition moments for the xenon halides.



Graphical Data A-4.23. III 1/2 - II 1/2 transition moments for the xenon halides.



Graphical Data. A-4.24. IV 1/2 - II 1/2 transition moments for the xenon halides.

Tabular Data. A-4.25. Calculated transition moments for the ionic-covalent transitions in XeCl with spin-orbit coupling included. (All quantities are in atomic units and only the z-components are given).

R	III 1/2-I 1/2	IV 1/2-I 1/2	III 1/2-II 1/2	IV 1/2-II 1/2	II 3/2-I 3/2
4.50	-0.9043	1.1567	0.8043	0.6095	1.0090
4.75	-1.0681	1.2110	0.6888	0.5690	0.8928
5.00	-1.2027	1.1843	0.5664	0.5086	0.7595
5.50	-1.2839	1.0061	0.3998	0.3537	0.5240
5.75	-1.2284	0.8995	0.3601	0.2739	0.4321
6.00	-1.1301	0.7962	0.3413	0.1983	0.3560
6.25	-1.0078	0.6997	0.3360	0.1291	0.2935
6.50	-0.8768	0.6110	0.3366	0.0680	0.2421
7.00	-0.6294	0.4559	0.3285	-0.0202	0.1655
8.00	-0.3077	0.2413	0.2317	-0.0659	0.0787

Tabular Data, A-4.26. Calculated transition moments for the ionic-covalent transitions in XeBr with spin-orbit coupling included. (All quantities are in atomic units and only the z-components are given).

R	III 1/2-I 1/2	IV 1/2-I 1/2	III 1/2-II 1/2	IV 1/2-II 1/2	II 3/2-I 3/2
4.50	-0.6632	0.8462	0.7501	0.5656	0.9388
5.00	-1.0437	1.1789	0.6807	0.4273	0.7893
5.50	-1.1826	1.0943	0.5921	0.2516	0.5780
5.75	-1.1636	1.0038	0.5788	0.1588	0.4857
6.00	-1.0937	0.9018	0.5754	0.0740	0.4061
6.25	-0.9912	0.7973	0.5692	0.0040	0.3387
6.50	-0.8748	0.6963	0.5516	-0.0470	0.2822
6.75	-0.7592	0.6031	0.5205	-0.0796	0.2351
7.00	-0.6528	0.5197	0.4788	-0.0970	0.1958
78.00	-0.3493	0.2830	0.2927	-0.0912	0.0951
10.00	-0.1045	0.0861	0.0899	-0.0359	0.0242

Tabular Data. A-4.27. Calculated transition moments for the ionic-covalent transitions in XeI with spin-orbit coupling included. (All quantities are in atomic units, and only the z-components are given).

R	III 1/2 - I 1/2	IV 1/2-I 1/2	III 1/2-II 1/2	IV 1/2-II 1/2	II 3/2-I 3/2
5.00	-0.7977	0.8021	0.6119	0.4560	0.7494
5.50	-1.0471	1.0242	0.6681	0.2435	0.6247
6.00	-1.0629	0.9590	0.6861	0.0535	0.4713
6.50	-0.9346	0.7955	0.6654	-0.0706	0.3418
6.75	-0.8460	0.7073	0.6325	-0.1042	0.2891
7.00	-0.7547	0.6231	0.5878	-0.1225	0.2440
7.50	-0.5845	0.4765	0.4811	-0.1293	0.1732
8.00	-0.4436	0.3606	0.3756	-0.1164	0.1226
10.00	-0.1393	0.1141	0.1194	-0.0480	0.0316

A-5. EMISSION ENERGIES AND WAVELENGTHS, TRANSITION MOMENTS, EINSTEIN COEFFICIENTS AND LIFETIMES FOR IONIC-COVALENT TRANSITIONS IN RARE GAS-FLUORIDES (RgF) AND XENON-HALIDES

CONTENTS

A-5. References

The tables in (A-5.1)-(A-5.9) are taken from the following sources:

(A-5.1),(A-5.3)-(A-5.6):

T. H. Dunning, Jr., and P. J. Hay, "The Low-Lying States of the Rare-Gas Fluorides," J. Chem. Phys. (to be published).

(A-5.2), (A-5.7)-(A-5.9):

P. J. Hay and T. H. Dunning, Jr., "Electronic States of the Xenon Halides," J. Chem. Phys. (to be published).

Tabular Data. A-5.1. Calculated emission energies and wavelengths, and transition moments, Einstein coefficients and lifetimes for the ionic-covalent transitions in the rare gas fluorides. (All quantities are computed at the R_e's of the upper states). (Units are as indicated).

Molecule	Transition	ΔE_{em} (eV)	λ_{em} (nm)	μ(D)	A(sec^{-1})	τ(nsec)
NeF	$2^2\Sigma^+ - X^2\Sigma^+$	10.84	114.	1.40	4.12×10^8	2.4
	$2^2\Pi - 1^2\Pi$	10.61	117.	0.37	2.67×10^7	38.
ArF	$2^2\Sigma^+ - X^2\Sigma^+$	6.49	191.	2.44	2.67×10^8	3.7
	$2^2\Pi - 1^2\Pi$	6.14	202.	0.74	2.12×10^7	47.
KrF	$2^2\Sigma^+ - X^2\Sigma^+$	5.27	235.	2.96	2.11×10^8	4.7
	$2^2\Pi - 1^2\Pi$	4.82	257.	0.99	1.81×10^7	55.
XeF	$2^2\Sigma^+ - X^2\Sigma^+$	4.03	307.	3.72	1.49×10^8	6.7
	$2^2\Pi - 1^2\Pi$	3.37	368	1.46	1.33×10^7	75.

Tabular Data. A-5.2. Calculated emission energies (ΔE) and wavelengths (λ), transition moments (μ), Einstein coefficients (A) and lifetimes (τ) for the ionic-covalent transitions in the xenon halides for electronic states without spin-orbit coupling.

Molecule	Transition	ΔE(eV)	λ(nm)	μ(D)	A(sec^{-1})	τ(nsec)
XeF	$2\ ^2\Sigma^+ - 1\ ^2\Sigma^+$	4.03	307.	3.72	1.5×10^8	6.7
	$2\ ^2\Pi - 1\ ^2\Pi$	3.37	368.	1.46	1.3×10^7	75.
XeCl	$2\ ^2\Sigma^+ - 1\ ^2\Sigma^+$	4.59	270.	3.32	1.8×10^8	5.6
	$2\ ^2\Pi - 1\ ^2\Pi$	4.28	290.	0.96	1.2×10^7	64.
XeBr	$2\ ^2\Sigma^+ - 1\ ^2\Sigma^+$	4.79	259.	3.17	1.8×10^8	5.6
	$2\ ^2\Pi - 1\ ^2\Pi$	4.54	273.	0.86	1.1×10^7	87.
XeI	$2\ ^2\Sigma^+ - 1\ ^2\Sigma^+$	5.00	248.	3.01	1.9×10^8	5.3
	$2\ ^2\Pi - 1\ ^2\Pi$	4.85	256.	0.74	1.0×10^7	97.

Tabular Data. A-5.3. Calculated and experimental emission energies, wavelengths and widths, transition moments, Einstein coefficients and lifetimes for the ionic-covalent transitions in NeF, with spin-orbit corrections. All quantities computed at the R_e's of the upper states. Units are as indicated.

Transition	ΔE_{em}(eV)		λ_{em}(nm)		$\Delta\lambda$(nm)	μ(D)	A(sec^{-1})	τ(nsec)
	Calc	Expt	Calc	Expt				
$III\frac{1}{2} - X\frac{1}{2}$	10.83	11.46[a]	114.	108.[a]	1.4	1.35	3.80×10^{8}	2.6
$IV\frac{1}{2} - X\frac{1}{2}$	11.02	-- --	113.	- -	1.5	0.39	3.40×10^{7}	29.
$II\frac{3}{2} - I\frac{3}{2}$	10.59	-- --	117.	- -	3.7	0.37	2.65×10^{7}	38.
$IV\frac{1}{2} - II\frac{1}{2}$	10.63	-- --	117.	-- --	3.7	0.33	2.16×10^{7}	46.
$III\frac{1}{2} - II\frac{1}{2}$	10.48	-- --	118.	-- --	3.6	0.18	6.31×10^{6}	158.

[a]Reference: J. K. Rice, A. K. Hays and J. R. Woodworth, Appl. Phys. Letts., 31, 31 (1977).

Tabular Data. A-5.4. Calculated and experimental emission energies, wavelengths and widths, and transition moments, Einstein coefficients and lifetimes for the ionic-covalent transitions in ArF, with spin-orbit corrections. All quantities computed at the R_e's of the upper states. Units are as indicated.

Transition	ΔE_{em} (eV)		λ_{em} (nm)		$\Delta\lambda$ (nm)	μ (D)	A(sec^{-1})	τ (nsec)
	Calc	Expt	Calc	Expt				
$III\frac{1}{2} - X\frac{1}{2}$	6.47	6.41[a,b]	192.	193.[a,b]	2.3	2.31	2.37×10^{8}	4.2
$IV\frac{1}{2} - X\frac{1}{2}$	6.70	-- --	185.	-- --	2.7	0.95	4.46×10^{7}	22.
$II\frac{3}{2} - I\frac{3}{2}$	6.10	-- --	203.	-- --	11.	0.74	2.07×10^{7}	48.
$IV\frac{1}{2} - II\frac{1}{2}$	6.23	-- --	199.	-- --	9.9	0.64	1.62×10^{7}	62.
$III\frac{1}{2} - II\frac{1}{2}$	6.08	-- --	204.	-- --	8.7	0.35	4.53×10^{6}	221.

[a]Reference: M. F. Golde and B. A. Thoush, Chem. Phys. Letts., 29, 486 (1974).
[b]Reference: J. G. Goodman and L. E. Brus, J. Chem. Phys. 65, 3808 (1976).

Tabular Data. A-5.5. Calculated and experimental emission energies, wavelengths and widths, and transition moments, Einstein coefficients and lifetimes for the ionic-covalent transitions in KrF, with spin-orbit corrections. (All quantities computed at the R_e's of the upper states. Units are as indicated).

Transition	ΔE_{em} (eV)		λ_{em} (nm)		$\Delta\lambda$ (nm)		μ(D)	A(sec^{-1})	τ(nsec)
	Calc	Expt	Calc	Expt	Calc	Expt			
$III\frac{1}{2} - X\frac{1}{2}$	5.10	5.00[a]	243.	248.[a]	2.6	2.0[a]	2.61	1.48×10^8	6.7
$IV\frac{1}{2} - X\frac{1}{2}$	5.80	5.64[b,c]	214.	220.[b,c]	2.3	- -	1.64	8.68×10^7	12.
$II\frac{3}{2} - I\frac{3}{2}$	4.61	4.51[b]	269.	275.[b]	19.	- -	0.99	1.58×10^7	63.
$IV\frac{1}{2} - II\frac{1}{2}$	5.27	- -	235.	- -	13.	- -	0.73	1.30×10^7	77.
$III\frac{1}{2} - II\frac{1}{2}$	4.65	- -	267.	- -	14.	- -	0.56	5.14×10^6	195.

[a]Reference C. A. Brau and J. J. Ewing, J. Chem. Phys. 63, 4640 (1975).
[b]Reference J. R. Murray and H. T. Powell, Appl. Phys. Letts. 29, 352 (1976).
[c]Reference: J. E. Velazco, J. H. Kolts and D. W. Setsen, J. Chem. Phys. 65, 3418 (1976).

Tabular Data. A-5.6. Calculated and experimental emission energies, wavelengths and widths, and transition moments, Einstein coefficients and lifetimes of the ionic-covalent transitions in XeF, with spin orbit corrections. (All quantities computed at the R_e's of the upper states. Units are as indicated).

Transition	ΔE_{em} (eV)		λ_{em} (nm)		$\nabla\lambda$ (nm)	μ (D)	$A(\mathrm{sec}^{-1})$	τ (nsec)	
	Calc	Expt	Calc	Expt				Calc	Expt
$III\frac{1}{2} - X\frac{1}{2}$	3.65	3.52[a]	340.	352.[a]	1.2	3.20	8.17×10^{7}	12.	16[b], 19[c], 13[d]
$IV\frac{1}{2} - X\frac{1}{2}$	4.98	4.70[a,e]	249.	264.[a,e]	0.85	2.28	1.06×10^{8}	9.5	<40[d]
$II\frac{3}{2} - I\frac{3}{2}$	2.94	∿2.75[a,e]	422.	∿450.[a,e]	47.	1.45	8.82×10^{6}	113.	100-150[d]
$IV\frac{1}{2} - II\frac{1}{2}$	4.34	- -	286.	- -	18.	0.99	1.33×10^{7}	75.	- -
$III\frac{1}{2} - II\frac{1}{2}$	3.13	- -	397.	- -	30.	0.76	2.94×10^{6}	340.	- -

[a]Reference : C. A. Brau and J. J. Ewing, J. Chem Phys. 63, 4640 (1975).

[b]Reference : J. G. Eden and S. K. Searles, Appl. Phys. Letts. 30, 287 (1977).

[c]Reference : R. Burnham and W. W. Harris, J. Chem. Phys. 66, 2742 (1977).

[d]Reference : J. J. Ewing, Seventh Winter Colloquium on Quantum Electronics, Park City, Utah, Feb. 1977.

[e]Reference : J. E. Velazco, J. H. Kolts and D. W. Setser, J. Chem. Phys. 65, 3468 (1926).

Tabular Data. A-5.7. Calculated and experimental emission energies (ΔE) and wavelengths (λ), transition moments (μ), Einstein coefficients (A) and lifetimes (τ) for the ionic-covalent transitions in XeCl.

XeCl Transitions	ΔE (eV) Calc	λ(nm) Expt	λ (nm) Calc	λ (nm) Expt	μ(D)	A(sec^{-1})	τ(nsec)
III 1/2 - I 1/2	4.20	4.03	295.	308.	2.76	9.3×10^{7}	11.
IV 1/2 - I 1/2	5.53	5.25	224.	236.	1.94	1.0×10^{8}	9.6
II 3/2 - I 3/2	3.76		330.		0.96	8.1×10^{6}	120.
IV 1/2 - II 1/2	5.13		242.		0.50	5.6×10^{6}	180.
III 1/2 - II 1/2	3.83		324.		0.87	6.0×10^{6}	140.

Tabular Data. A-5.8. Calculated and experimental emission energies (ΔE) and wavelengths(λ), transition moments (μ), Einstein coefficients (A) and lifetimes (τ) for the ionic-covalent transitions in XeBr.

XeBr Transitions	ΔE_{em}(eV)		λ(nm)		μ(D)	A(sec^{-1})	τ(nsec)
	Calc	Expt	Calc	Expt			
III 1/2 - I 1/2	4.48	4.40	277.	282.	2.35	8.2×10^7	12.
IV 1/2 - I 1/2	5.81		213.		1.88	1.1×10^8	8.8
II 3/2 - I 3/2	4.10		302.		0.86	8.4×10^6	120.
IV 1/2 - II 1/2	5.17		240.		0.02	1.4×10^4	73. x 10
III 1/2 - II 1/2	3.86		321.		1.44	2.0×10^7	51.

Tabular Data. A-5.9. Calculated and experimental emission energies (ΔE) and wavelengths(λ), transition moments (μ), Einstein coefficients (A), and lifetimes (τ) for the ionic-covalent transitions in XeI.

XeI Transitions	ΔE (eV)		λ (nm)		μ(D)	A(sec^{-1})	τ (nsec)
	Calc	Expt	Calc	Expt			
III 1/2 - I 1/2	4,85	4.90	256.	253.	2.07	8.0×10^7	12.
IV 1/2 - I 1/2	6.19	6.11	200.	203.	1.72	1.2×10^8	8.6
II 3/2 - I 3/2	4.72	4.25	263.	292.	0.74	9.4×10^6	110.
IV 1/2 - II 1/2	5.13		242.		0.27	1.6×10^6	610.
III 1/2 - II 1/2	3.80	3.76	326.	330.	1.59	2.3×10^7	44.

A-6. POTENTIAL-ENERGY CURVES, SPECTROSCOPIC DATA, ABSORPTION DATA AND ABSORPTION SPECTRA FOR THE MOLECULAR IONS He_2^+, Ne_2^+, Ar_2^+, Kr_2^+, Xe_2^+

CONTENTS

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A-6. References

The figures and tables in (A-6.1)-(A-6.37) are taken from the following sources:

(A-6.1),(A-6.35)-(A-6.37):

T. L. Gilbert and A. C. Wahl, "Single-Configuration Wave Functions and Potential Curves for Low-Lying States of He_2^+, Ne_2^+, Ar_2^+, F_2^-, $C\ell_2^-$ and the Ground State of $C\ell_2$," J. Chem. Phys. 55, 5247 (1971).

(A-6.2),(A-6.3):

R. J. Blint, "Spectrum of potential-energy curves for the He_2^+ system," Phys. Rev. A 14, 2055 (1976).

(A-6.4):

R. S. Mulliken, "Rare Gas and Hydrogen Molecule Electronic States, Noncrossing Rule, and Recombination of Electronic with Rare-Gas and Hydrogen Ions." Phys. Rev. A 136, 962 (1964).

(A-6.5)-(A-6.9):

J. S. Cohen and B. Schneider, "Ground and Excited States of Ne_2 and Ne_2^+. I. Potential curves with and without spin-orbit coupling," J. Chem. Phys. 61, 3230 (1974).

(A-6.10)-(A-6.17),(A-6.20)-(A-6.32),(A-6.33):

W. R. Wadt, "The Electronic States of Ar_2^+, Kr_2^+ and Xe_2^+. I. Potential curves with and without spin-orbit coupling," J. Chem. Phys. 68, 402 (1978).

(A-6.18),(A-6.19):

J. T. Moseley, R. P. Saxon, B. A. Huber, P. C. Cosby, R. Abouaf and M. Tadjeddine, "Photofragment spectroscopy and potential curves of Ar_2^+," J. Chem. Phys. 67, 1659 (1977).

(A-6.32):

R. S. Mulliken, "Potential curves of diatomic rare-gas molecules and their ions, with particular reference to Xe_2^*," J. Chem. Phys. 52, 5170 (1970).

(A-6.34):

W. R. Wadt, D. C. Cartwright and J. S. Cohen, "Theoretical absorption spectra for Ne_2^+, Ar_2^+, Kr_2^+ and Xe_2^+ in the near ultraviolet," Appl. Phys. Letts. (to be published).

Calculated potential curves for the ground states.

He_2^+										
R (bohrs)	1.50	1.75	2.00	2.25	2.50	3.00	3.50	4.00	5.00	6.00
$U(R)^a$ (eV)	−1.16	−2.38	−2.67	−2.52	−2.18	−1.45	−0.84	−0.48	−0.16	−0.07
Ne_2^+										
R (bohrs)	2.50	2.80	3.00	3.20	3.50	4.00	5.00			
$U(R)^a$ (eV)	+0.79	−1.14	−1.56	−1.65	−1.49	−1.03	−0.39			
Ar_2^+										
R (bohrs)	3.80	4.00	4.20	4.30	4.50	4.60	4.70	5.00	5.50	
$U(R)^a$ (eV)	+0.04	−0.63	−1.00	−1.12	−1.23	−1.25	−1.25	−1.15	−0.89	
F_2^-										
R (bohrs)	2.68	3.20	3.60	4.00	4.40	4.80	5.20	5.80	6.60	
$U(R)^a$ (eV)	+0.94	−1.10	−1.66	−1.50	−1.24	−0.99	−0.78	−0.55	−0.35	
Cl_2^-										
R (bohrs)	3.80	4.00	4.50	4.70	5.00	5.10	5.50	6.00	7.00	
$U(R)^a$ (eV)	+0.94	+0.04	−1.05	−1.21	−1.28	−1.28	−1.18	−0.98	−0.60	
Cl_2										
R (bohrs)	3.60	3.756	3.80	3.90	4.20					
$U(R)^b$ (eV)	+1.04	+0.91	+0.91	+0.94	+1.30					

[a] Relative to dissociated system: $U(\infty)=0$.

[b] Relative to $E_{Cl}+E_{Cl^-}$: $U(\infty)=3.42$ eV.

Ground state potential curve characteristics.

	D_e (eV) Calc	D_e (eV) Exptl	R_e (bohr) Calc	ω_e (cm^{-1}) Calc	B_e (cm^{-1}) Calc	ΔE_{LR} [a] (eV) Calc
He_2^+	2.67	2.49[b] (2.33[c])	2.0[d]	1790[d]	7.4[d]	1.02
Ne_2^+	1.65	1.35±0.07[e] (1.1[c])	3.2	660	0.59	1.77
Ar_2^+	1.25	1.6±0.3[f] (1.4[c])	4.6	300	0.139	0.69
F_2^-	1.66	1.29±0.1[g]	3.6	510	0.50	1.89
Cl_2^-	1.28	1.26±0.1[g]	5.0	260	0.136	0.78
Cl_2	0.87	2.5143[h]	3.8	577	0.24	...

[a] Limiting value of left-right correlation energy for $R\rightarrow\infty$. See text.

[b] R. E. Olson and C. R. Mueller, J. Chem. Phys. 46, 3810 (1967). This figure is based on the 10 eV scattering data of Lorents and Aberth. The value obtained from scattering at 15 eV is $D_e=2.34$ eV.

[c] Mulliken's estimates of the "true" values. See R. S. Mulliken, J. Chem. Phys. 52, 5170 (1970).

[d] Experimental values are $R_e=2.04$, $\omega_e=1627$, and $B_e=7.22$. [G. Herzberg, *Molecular Spectra and Molecular Structure I. Spectra of Diatomic Molecules* (Van Nostrand-Reinhold, 1950).] Reagan *et al.* [J. Chem. Phys. 32, 304 (1963)] obtain $D_e=2.30$, $R_e=2.06$, $\omega_e=1646$, and $B_e=6.99$ from a 26-term multiconfiguration calculation.

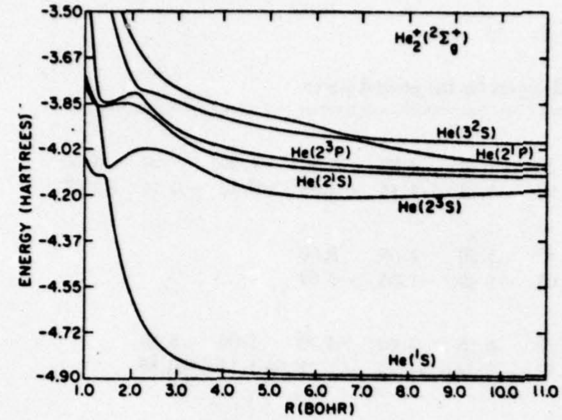
[e] J. R. Connor and M. A. Biondi, Phys. Rev. 140, A778 (1965); L. Frommhold and M. A. Biondi, Phys. Rev. 185, 244 (1969).

[f] W. Aberth and D. C. Lorents, Phys. Rev. 144, 109 (1966).

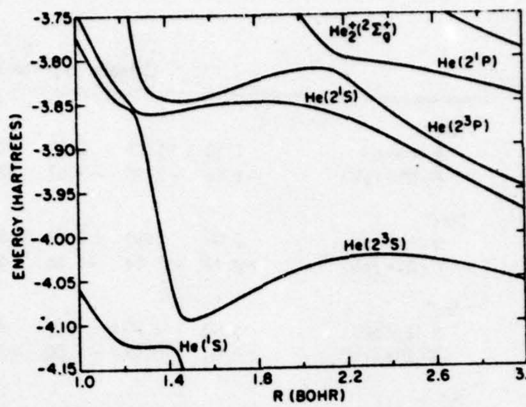
[g] W. A. Chupka, J. Berkowitz, and D. Gutman, J. Chem. Phys. 55, 2724 (1971).

[h] A. E. Douglas, C. K. Moeller, and B. P. Stoicheff, Can. J. Phys. 41, 1174 (1963). Experimental values for the other constants are $R_e=3.756$, $\omega_e=559.71$, and $B_e=0.24407$. Cl_2 is the only one of the above systems for which the MO wavefunction does not dissociate to the proper limit.

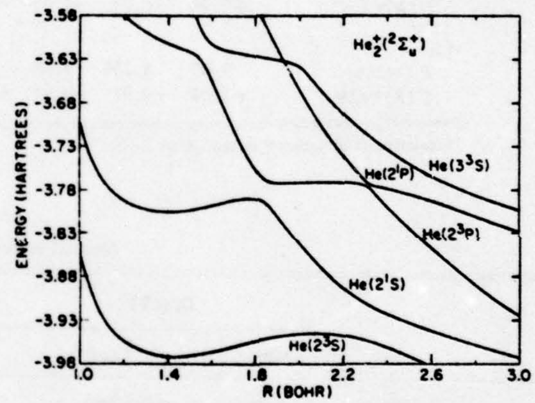
Tabular Data. A-6.1. He_2^+, Ne_2^+, Ar_2^+, F_2^-, $C\ell_2^-$, $C\ell_2$.



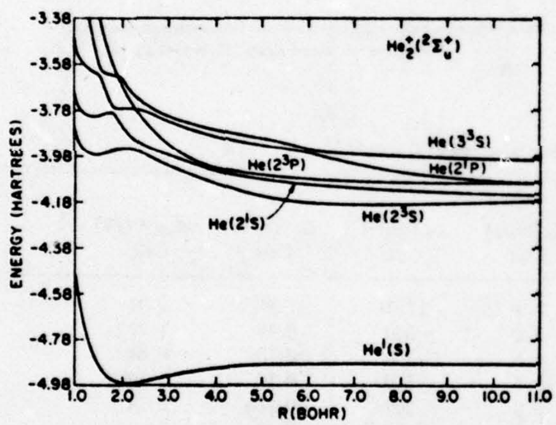
Spectrum of calculated potential-energy curves for the $^2\Sigma_g^+$ symmetry state. Each curve is labeled with the state of the neutral species at the asymptotic limit. The complementary ionic species in each case is in its ground state. The units are hartrees (= 27.2 eV) and bohr (=0.529 Å).



Expanded section of the interacting potential-energy curves

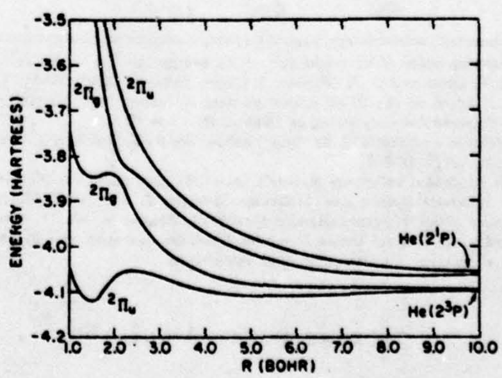


Expanded section of the interacting potential-energy curves for the $^2\Sigma_u^+$ states.



Spectrum of calculated potential-energy curves for the $^2\Sigma_u^+$ symmetry state.

Graphical Data. A-6.2. He_2^+



ALSO **Potential-energy curves for the $^2\Pi_{g,u}$ states of He_2^+.**

Symmetries and excitation energies of the lower symmetry states of the He_2^+ molecular collision complex. All energies are in eV's.

$He^+(^2S) + He(^1S)$	$^2\Sigma_{g,u}^+$	0.0
$He^+(^2S) + He(^3 2S)$	$^4\Sigma_{g,u}^+, ^2\Sigma_{g,u}^+$	19.82
$He^+(^2S) + He(^1 2S)$	$^2\Sigma_{g,u}^+$	20.61
$He^+(^2S) + He(^3 2P)$	$^4\Sigma_{g,u}^+, ^2\Sigma_{g,u}^+, ^4\Pi_{g,u}, ^2\Pi_{g,u}$	20.96
$He^+(^2S) + He(^1 2P)$	$^2\Sigma_{g,u}^+, ^2\Pi_{g,u}$	21.22
$He^+(^2S) + He(^3 3S)$	$^4\Sigma_{g,u}^+, ^2\Sigma_{g,u}^+$	22.72
$He^+(^2S) + He(^1 3S)$	$^2\Sigma_{g,u}^+$	22.92

Asymptotic energies of the CI calculations for the $^2\Sigma_g^+$ and $^2\Sigma_u^+$ states of the $(He_2)^+$ complex. All energies are in eV.

Neutral excitations	Calc.	Expt.[a]	Δ(Expt. – Calc.)
$He(^1S)$-$He(^3S)$	19.41	19.82	0.41
$He(^1S)$-$He(^1 2S)$	20.22	20.61	0.39
$He(^1S)$-$He(^3P)$	21.34	20.96	−0.38
$He(^1S)$-$He(^1P)$	21.87	21.22	−0.65
$He(^1S)$-$He(^3 2S)$	23.66	22.72	−0.94

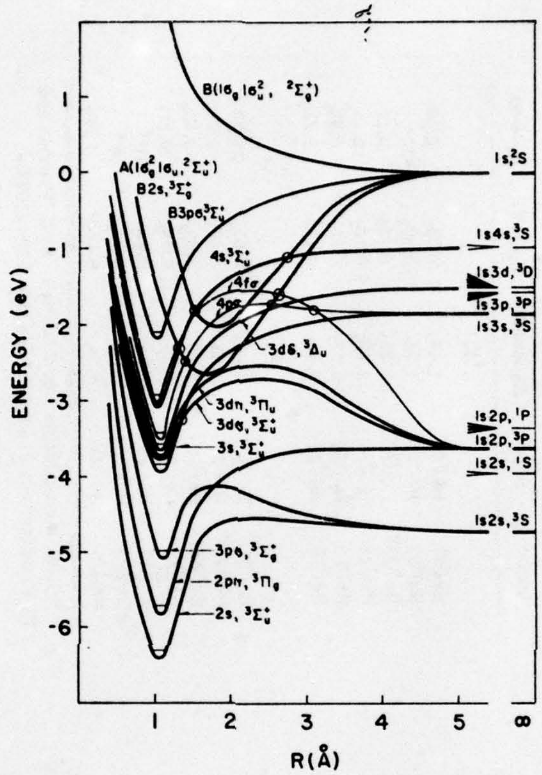
[a]Reference C. E. Moore, Atomic Energy Levels, NSRDS-NBS Civ. No.35 (U.S. GPO. Washington, D. C., 1971)

Avoided crossings for the $(He_2)^+$ complex for both the $^2\Sigma_g^+$ and $^2\Sigma_u^+$ states. V_{ij} for these states is $\frac{1}{2}$ the minimum energy splitting between the states. The critical energy E_c is the energy at which the LZS transition probability is 0.37.[a]

States				
Initial	Final	R_0 (bohr)	V_{ij} (eV)	E_c (eV)
		$^2\Sigma_g^+$		
$He(^1S)$	$He(^3S)$	1.44_2	0.73_7	0.49_7
$He(^3S)$	$He(^1 2S)$	1.25_2	0.07_6	$<10^{-3}$
$He(^1 2S)$	$He(^3P)$	1.53_2	0.12_2	0.10_7
$He(^1 2S)$	$He(^3P)$	2.70_6	0.13_3	12.79_3
$He(^3P)$	$He(^1P)$	2.17_2	0.30_2	0.35_8
$He(^1P)$	$He(^3 2S)$	6.80_9	0.17_5	2.75_5
		$^2\Sigma_u^+$		
$He(^3S)$	$He(^1 2S)$	2.44_0	0.52_0	20.72_1
$He(^1 2S)$	$He(^3P)$	1.83_9	0.36_5	0.27_2
$He(^1 2S)$	$He(^3P)$	3.73_0	0.08_3	0.13_8
$He(^3P)$	$He(^1P)$	1.56_4	0.45_4	0.31_7
$He(^3P)$	$He(^1P)$	2.31_1	0.05_9	$<10^{-3}$
$He(^1P)$	$He(^3 2S)$	1.92_5	0.01_8	$<10^{-5}$
$He(^1P)$	$He(^3 2S)$	5.94_8	0.17_6	1.90_3

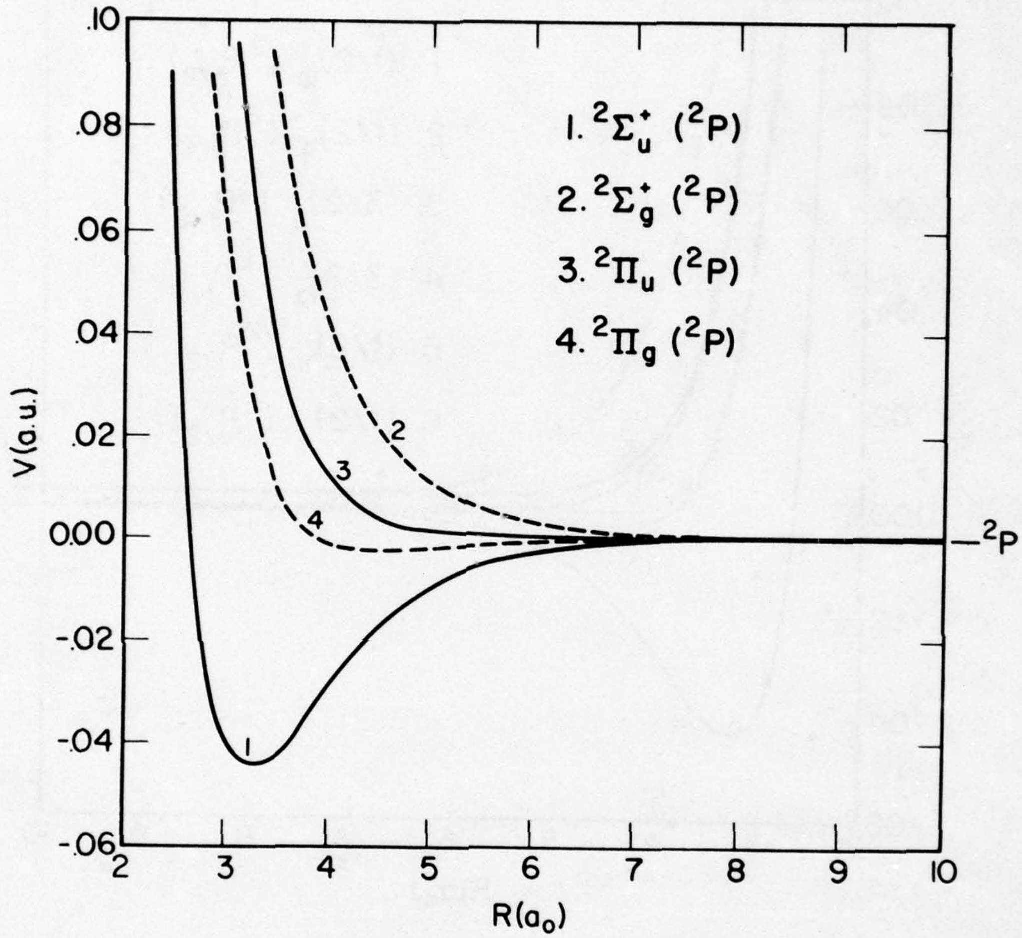
[a]C. W. Bauschlecher, S. V. O'Neil, R. K. Preston and H. F. Schaeffer, J. Chem. Phys. 59, 1286 (1973).

Tabular Data A-6.3. He_2^+



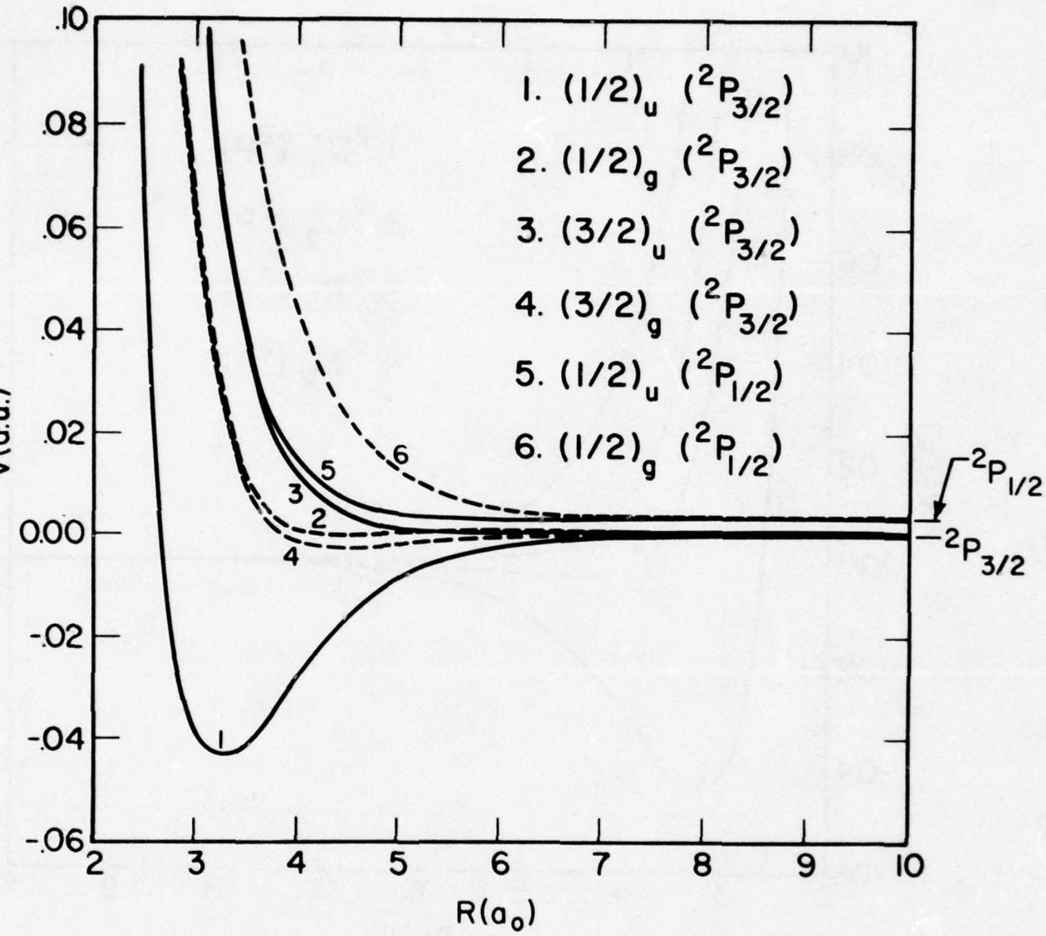
Potential curves of He_2^+ and of some triplet states of He_2. For the ten lower states shown, which have *A* core, the curve shapes near their minima and their depths relative to the *A* curve of He_2^+ are based on experimental data, except for $4p\sigma$ and $4f\sigma$. The absolute depths of all these curves are based on an *assumed* value of 2.1 eV for the dissociation energy D^+ of the $v=0$ level of He_2^+. The forms of the *B*-core curves, and of the *A*-core curves at larger *R* values, have no more than qualitative justification. Circles, for example where $A3s$ intersects $A3d\sigma$, and where $A4s$ intersects $B\ 3p\sigma$ (twice), indicate crossings which, although not so shown, *should* be avoided according to the noncrossing rule. For every triplet state of He_2 a corresponding singlet state exists, but to avoid confusion these are omitted

Graphical Data A-6.4. He_2^+



Graphical Data A-6.5. Ne_2^+

Potential curves for the states of Ne_2^+ formed in the interaction of $Ne^+(2p^5, {}^2P)$ with ground-state Ne, not including spin-orbit coupling. Curves for the ungerade states are shown solid and curves for the gerade states are shown dashed.



Graphical Data A-6.6. Potential curves of Ne_2^+ including the effects of spin-orbit coupling.

Tabular Data A-6.7.

Potential energies of Ne_2^+ before spin-orbit coupling [relative to the separated-atom limit, i.e. $V(R) = E(R) - E(\infty)$].

$R[a_0]$	V(R) [a.u.]			
	$^2\Sigma_u^+$	$^2\Sigma_g^+$	$^2\Pi_u$	$^2\Pi_g$
2.5	0.06288	0.50554	0.39732	0.26352
3.0	-0.03906	0.19912	0.11981	0.06015
3.5	-0.04220	0.08791	0.03753	0.00965
4.0	-0.02904	0.04233	0.01219	-0.00132
5.0	-0.01001	0.01117	0.00129	-0.00208
6.0	-0.00308	0.00307	0.00002	-0.00085
7.0	-0.00098	0.00080	-0.00011	-0.00035
8.0	-0.00035	0.00017	-0.00010	-0.00015

Tabular Data A-6.8. Potential energies of N_2^+ including spin-orbit effects. [a,b]

$R[a_o]$	V(R) [a.u.]			
	$(1/2)_u(^2P_{3/2})$	$(1/2)_g(^2P_{3/2})$	$(1/2)_u(^2P_{1/2})$	$(1/2)_g(^2P_{1/2})$
2.5	0.06406	0.26588	0.39614	0.50318
3.0	-0.03789	0.06250	0.11864	0.19676
3.5	-0.04105	0.01199	0.03638	0.08557
4.0	-0.02792	9.89×10^{-4}	0.01107	0.04002
5.0	-0.00904	6.59×10^{-5}	3.24×10^{-4}	0.00902
6.0	-0.00247	7.26×10^{-4}	-5.92×10^{-4}	0.00149
7.0	-7.33×10^{-4}	3.24×10^{-4}	-3.59×10^{-4}	1.21×10^{-4}
8.0	-2.68×10^{-4}	5.70×10^{-5}	-1.76×10^{-4}	-3.70×10^{-5}

[a]The energy of Ne^+ $(^2P_{1/2})$ relative to the ground state $Ne(^2P_{3/2})$ is 0.00356 a.u.

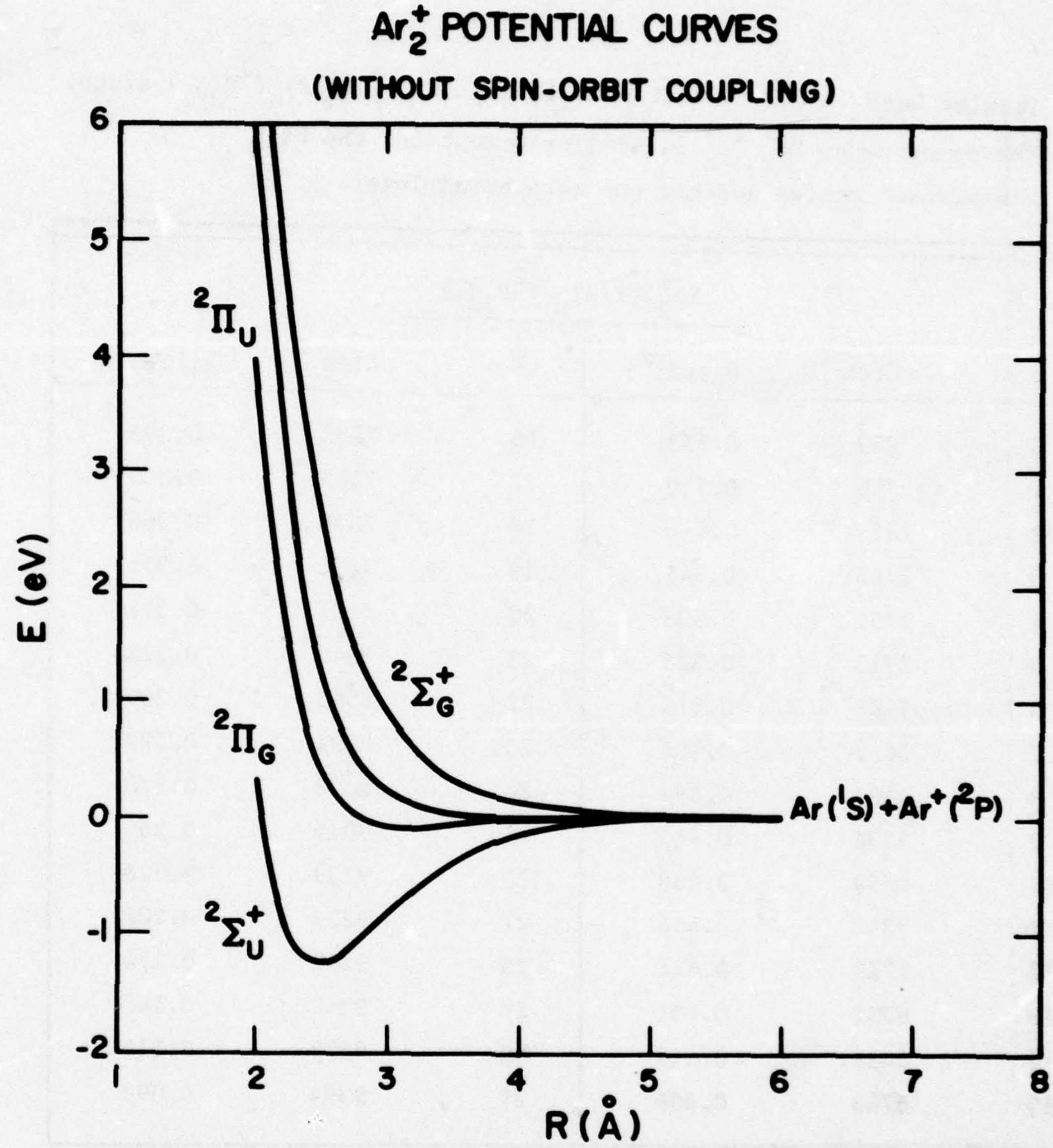
[b]The Ne_2^+ $(3/2)_{u,g}$ $(^2P_{3/2})$ potential curves are the same as those listed in Table for Ne_2^+ $^2\Pi_{u,g}(^2P)$.

Tabular Data. A-6.9. Vibrational levels of Ne_2^+ $(1/2)_u(^2P_{3/2})$ state. The spectrum of Ne_2^+ $^2\Sigma_u^+$ is similar except for the high vibrational states and has one more bound level.

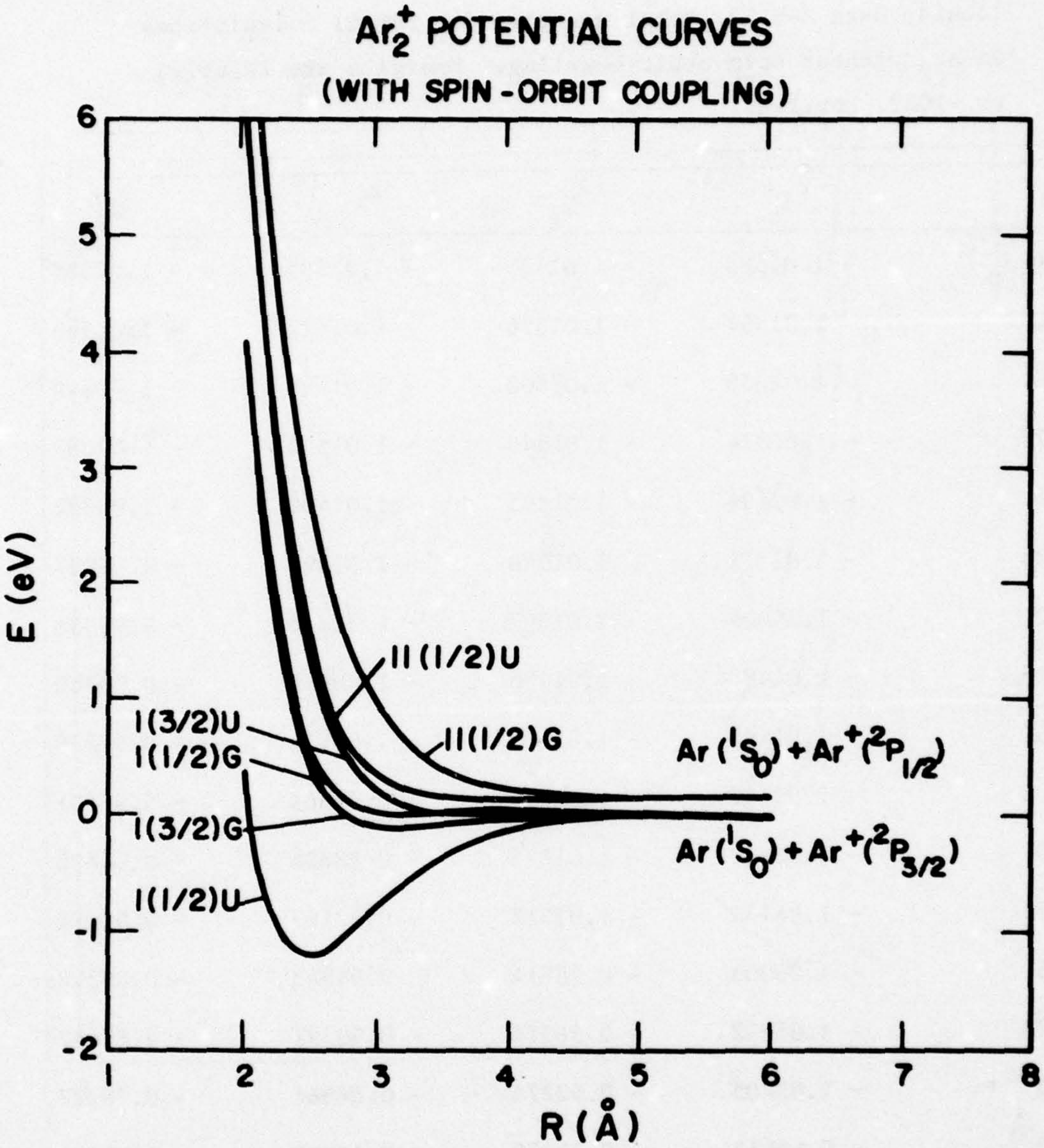
	Ne_2^+ $(1/2)_u$ $(^2P_{3/2})$				
v	G[cm^{-1}]	B_v[cm^{-1}]	v	G[cm^{-1}]	B_v[cm^{-1}]
0	253	0.553	16	7072	0.393
1	756	0.550	17	7363	0.380
2	1253	0.546	18	7636	0.366
3	1744	0.541	19	7891	0.352
4	2231	0.533	20	8127	0.322
5	2713	0.525	21	8345	0.322
6	3188	0.515	22	8543	0.306
7	3652	0.504	23	8721	0.289
8	4101	0.492	24	8878	0.270
9	4534	0.480	25	9015	0.250
10	4950	0.468	26	9130	0.228
11	5348	0.456	27	9223	0.202
12	5729	0.444	28	9292	0.174
13	6091	0.431	29	9342	0.148
14	6436	0.419	30	9375	0.119
15	6763	0.406	31	9394	0.093

D_e = 9401 cm^{-1}

R_e = 1.75 x 10^{-8} cm



Graphical Data A-6.10. Ar_2^+



Graphical Data. A-6.11. Ar_2^+

Tabular Data A-6.12. Total energies for POL CI calculations on Ar_2^+ without spin-orbit coupling. Energies are relative to -1052. hartrees.

R	$^2\Sigma_u^+$	$^2\Pi_g$	$^2\Pi_u$	$^2\Sigma_g^+$
20.0 a_o	- 1.01585	- 1.01585	- 1.01585	- 1.01585
8.0	- 1.01957	- 1.01676	- 1.01622	- 1.01366
7.0	- 1.02608	- 1.01800	- 1.01584	- 1.00840
6.75	- 1.02874	- 1.01846	- 1.01550	- 1.00605
6.5	- 1.03194	- 1.01895	- 1.01490	- 1.00302
6.25	- 1.03571	- 1.01940	- 1.01390	- 0.99907
6.0	- 1.04004	- 1.01967	- 1.01226	- 0.99388
5.75	- 1.04486	- 1.01956	- 1.00960	- 0.98700
5.5	- 1.04995	- 1.01867	- 1.00534	- 0.97778
5.25	- 1.05492	- 1.01639	- 0.99861	- 0.96531
5.0	- 1.05910	- 1.01173	- 0.98806	- 0.94828
4.75	- 1.06139	- 1.00312	- 0.97167	- 0.92478
4.5	- 1.06003	- 0.98814	- 0.94643	- 0.89212
4.25	- 1.05232	- 0.96316	- 0.90791	- 0.84642
4.0	- 1.03405	- 0.92274	- 0.84961	- 0.78227
3.0	- 0.65613	- 0.37623	- 0.15502	- 0.15449

Tabular Data A-6.13. Spectroscopic data for the ground state of Ar_2^+ with and without spin-orbit coupling.

	D_e(eV)	R_e(Å)	ω_e(cm^{-1})	B_e(cm^{-1})
$1^2\Sigma_u^+$	1.24	2.48	293	0.137
I(1/2)u	1.19	2.48	293	0.137

Tabular Data A-6.14. Absorption data for Ar_2^+ with and without spin-orbit coupling.

	ΔE(eV)	λ(nm)	M(D)	f
$1^2\Sigma_u^+ \rightarrow 1^2\Pi_g$	1.66	745	0.09	5.0×10^{-5}
$\rightarrow 1^2\Sigma_g^+$	3.89	319	5.26	0.41
$I(1/2)_u \rightarrow I(3/2)_g$	1.61	772	0.06	2.4×10^{-5}
$\rightarrow I(1/2)_g$	1.72	720	0.38	9.2×10^{-4}
$\rightarrow II(1/2)_g$	3.89	318	5.22	0.40

The vertical transition energies are calculated at R_e as are the transition moments (M) and oscillator strengths (f).

Tabular Data A-6.15. Total energies for POL CI calculations on Ar_2^+ with spin-orbit coupling. (Energies are relative to -1052. hartrees).

R	I(1/2)u	II(1/2)u	I(3/2)u	I(1/2)g	II(1/2)g	I(3/2)g
20.0 a_o	- 1.01802	- 1.01150	- 1.01802	- 1.01802	- 1.01150	- 1.01802
8.0	- 1.02094	- 1.01267	- 1.01839	- 1.01723	- 1.01101	- 1.01893
7.0	- 1.02680	- 1.01294	- 1.01801	- 1.01693	- 1.00729	- 1.02017
6.75	- 1.02933	- 1.01273	- 1.01767	- 1.01713	- 1.00519	- 1.02063
6.5	- 1.03242	- 1.01224	- 1.01707	- 1.01743	- 1.00236	- 1.02112
6.25	- 1.03609	- 1.01133	- 1.01607	- 1.01773	-.99856	- 1.02157
6.0	- 1.04035	- 1.00977	- 1.01443	- 1.01788	-.99348	- 1.02184
5.75	- 1.04511	- 1.00717	- 1.01177	- 1.01769	-.98669	- 1.02173
5.5	- 1.05015	- 1.00296	- 1.00751	- 1.01673	-.97753	- 1.02084
5.25	- 1.05508	-.99627	- 1.00078	- 1.01440	-.96511	- 1.01856
5.0	- 1.05922	-.98575	-.99023	- 1.00970	-.94812	- 1.01390
4.75	- 1.06149	-.96939	-.97384	- 1.00106	-.92465	- 1.00529
4.5	- 1.06011	-.94417	-.94860	-.98606	-.89201	-.99031
4.25	- 1.05238	-.90567	-.91008	-.96106	-.84633	-.96533
4.0	- 1.03410	-.84738	-.85178	-.92063	-.78220	-.92491
3.0	-.65614	-.15282	-.15719	-.37409	-.15444	-.37840

Tabular Data A-6.16. Comparison of <u>ab initio</u> calculations for the dipole-allowed absorptions in Ar_2^+.

	$^2\Sigma_u^+ \rightarrow {}^2\Sigma_g^+$		$^2\Sigma_u^+ \rightarrow {}^2\Pi_g$	
	λ(nm)	M(D)	λ(nm)	M(D)
Stevens[a]	299	5.74	705	0.09
This Work	319	5.26	745	0.09

[a]Reference: W. J. Stevens, M. Gardner and A. Karo (to be published).

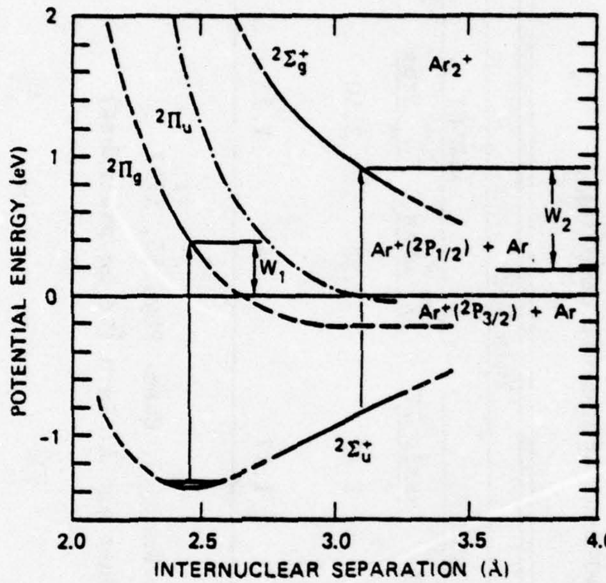
Tabular Data A-6.17. Comparison of the *ab initio* calculations on the $^2\Sigma_u^+$ state of Ar_2^+ without spin-orbit coupling.

	Gilbert Wahl[a]	Stevens[b]	This Work				
			SCF		POL CI		
			Basis I	Basis IV	$^1\Sigma_g^+$ orbs	$^2\Sigma_u^+$ orbs	$^2\Pi_g$ orbs
R_e (Å)	2.46	2.46	2.50	2.49	2.50	2.50	2.50
D_e (eV)	1.25	1.20	1.17	1.17	1.24	1.21	1.21

[a] Reference: T.L. Gilbert and A. C. Wahl, J. Chem. Phys 55, 5247

[b] Reference: W. J. Stevens. M. Gardner and A. Karo (to be published)

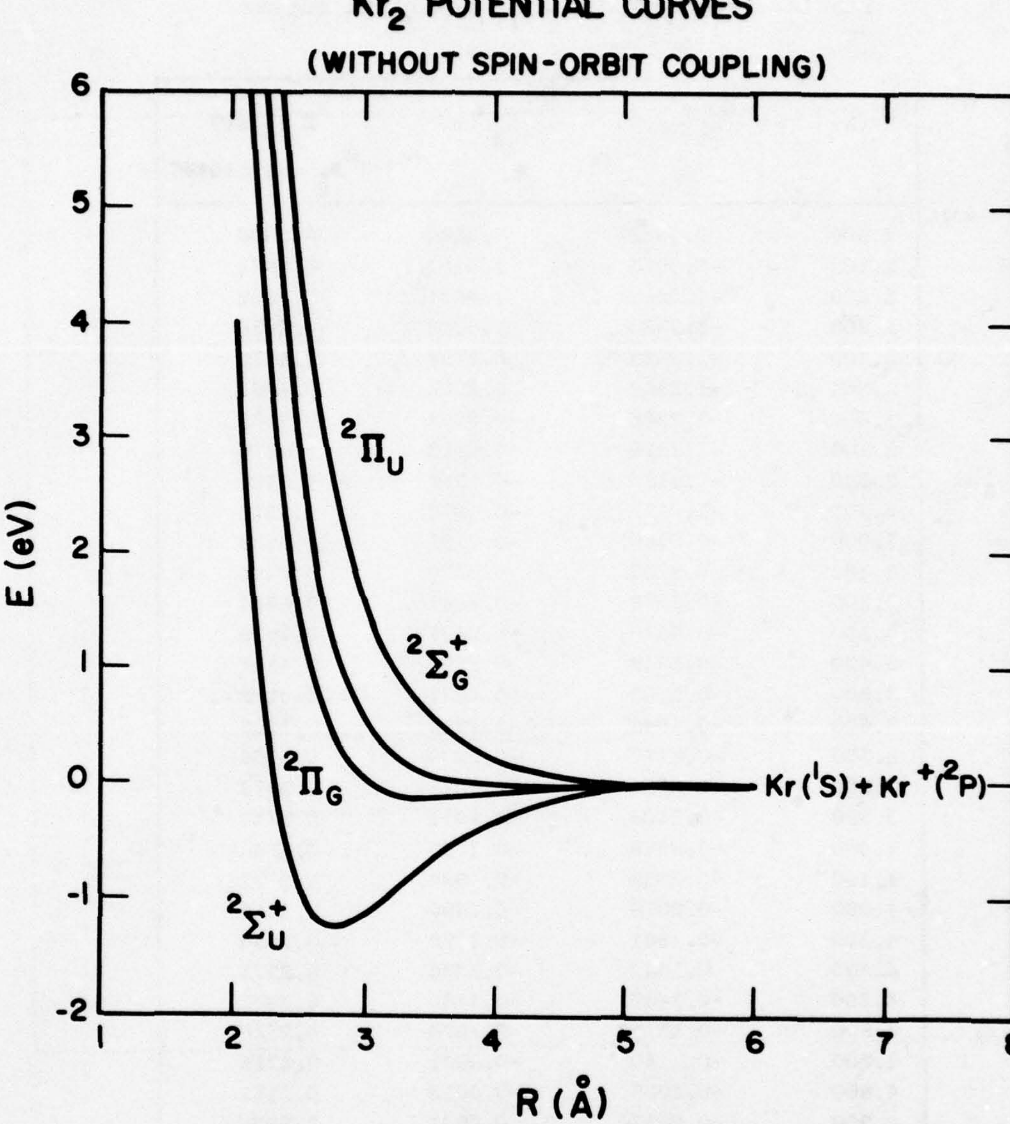
(Indicated transitions correspond to 7525 Å)



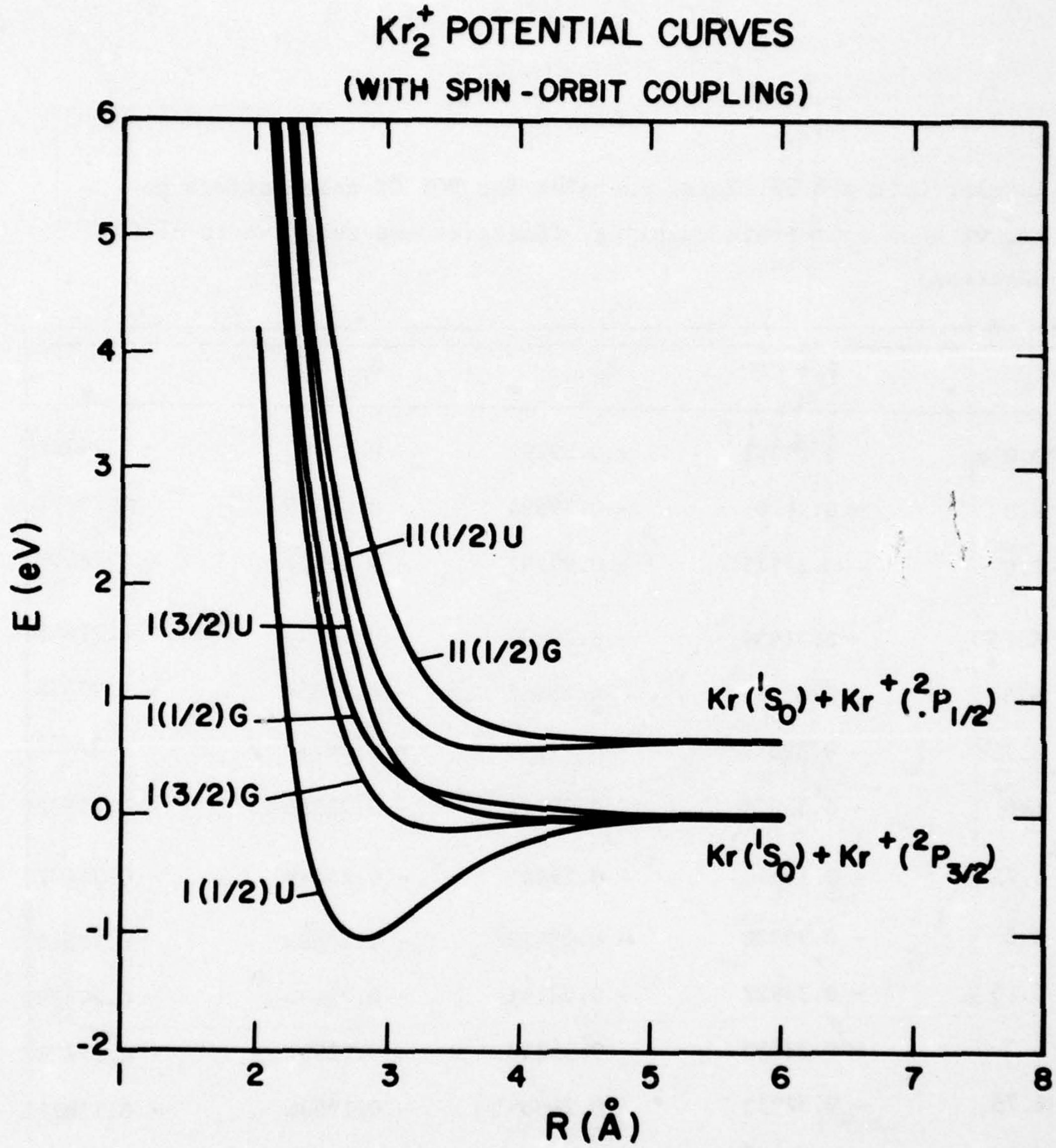
Graphical Data A-6.18. Potential curves of Ar_2^+.

Tabular Data A-6.19. Ar_2^+ potential curves

R (Å)	$^2\Sigma_u^+$ (eV)	$^2\Pi_g$ (eV)	$^2\Sigma_g^+$ (eV) ($^2P_{\frac{1}{2}}$ asymptote)
2.000	0.4513	3.3920	8.3636
2.100	-0.5955	2.5181	6.8974
2.200	-1.0552	1.6671	5.4602
2.300	-1.2333	1.0068	4.2638
2.400	-1.3328	0.5796	3.3716
2.500	-1.3368	0.2807	2.6661
2.600	-1.2886	0.0798	2.1138
2.700	-1.2119	-0.0513	1.6810
2.800	-1.1180	-0.1356	1.3591
2.900	-1.0172	-0.1872	1.1319
3.000	-0.9186	-0.2191	0.9439
3.100	-0.8252	-0.2370	0.7895
3.200	-0.7378	-0.2441	0.6644
3.300	-0.6573	-0.2437	0.5635
3.400	-0.5845	-0.2392	0.4811
3.500	-0.5203	-0.2337	0.4113
3.600	-0.4648	-0.2286	0.3526
3.700	-0.4177	-0.2239	0.3066
3.800	-0.3596	-0.2071	0.2875
3.900	-0.3104	-0.1911	0.2779
4.000	-0.2696	-0.1762	0.2741
4.100	-0.2359	-0.1624	0.2731
4.200	-0.2078	-0.1496	0.2716
4.300	-0.1841	-0.1378	0.2665
4.400	-0.1640	-0.1270	0.2575
4.500	-0.1467	-0.1169	0.2461
4.600	-0.1316	-0.1076	0.2336
4.700	-0.1180	-0.0991	0.2215
4.800	-0.1055	-0.0913	0.2111
4.900	-0.0937	-0.0841	0.2030
5.000	-0.0824	-0.0775	0.1970
5.100	-0.0719	-0.0714	0.1927
5.200	-0.0620	-0.0658	0.1896
5.300	-0.0529	-0.0608	0.1875
5.400	-0.0446	-0.0561	0.1858
5.500	-0.0371	-0.0519	0.1846
5.600	-0.0305	-0.0480	0.1836
5.700	-0.0248	-0.0445	0.1828
5.800	-0.0202	-0.0412	0.1821
5.900	-0.0166	-0.0383	0.1814
6.000	-0.0139	-0.0356	0.1806



Graphical Data A-6.20. Kr_2^+



Graphical Data A-6.21. Kr_2^+

Tabular Data A-6.22. Total energies for POL CI calculations on Kr_2^+ without spin-orbit coupling. (Energies are relative to -5503. hartrees)

R	$^2\Sigma_u^+$	$^2\Pi_g$	$^2\Pi_u$	$^2\Sigma_g^+$
20.0 a_o	- 0.29392	- 0.29392	- 0.29392	- 0.29392
8.0	- 0.30201	- 0.29595	- 0.29456	- 0.28924
7.0	- 0.31275	- 0.29791	- 0.29333	- 0.28039
6.75	- 0.31659	- 0.29834	- 0.29227	- 0.27646
6.5	- 0.32085	- 0.29855	- 0.29054	- 0.27136
6.25	- 0.32541	- 0.29830	- 0.28779	- 0.26467
6.0	- 0.33006	- 0.29724	- 0.28350	- 0.25582
5.75	- 0.33440	- 0.29481	- 0.27689	- 0.24402
5.5	- 0.33780	- 0.29013	- 0.26683	- 0.22818
5.25	- 0.33927	- 0.28191	- 0.25166	- 0.20679
5.0	- 0.33729	- 0.26818	- 0.22898	- 0.17776
4.75	- 0.32953	- 0.24605	- 0.19536	- 0.13821
4.25	- 0.28098	- 0.15773	- 0.07343	- 0.00992
3.5	+ 0.00177	+ 0.22596	+ 0.40306	+ 0.41398

Tabular Data A-6.23. Total energies for POL CI calculations in Kr_2^+ with spin-orbit coupling. (Energies are relative to -5503. hartrees.

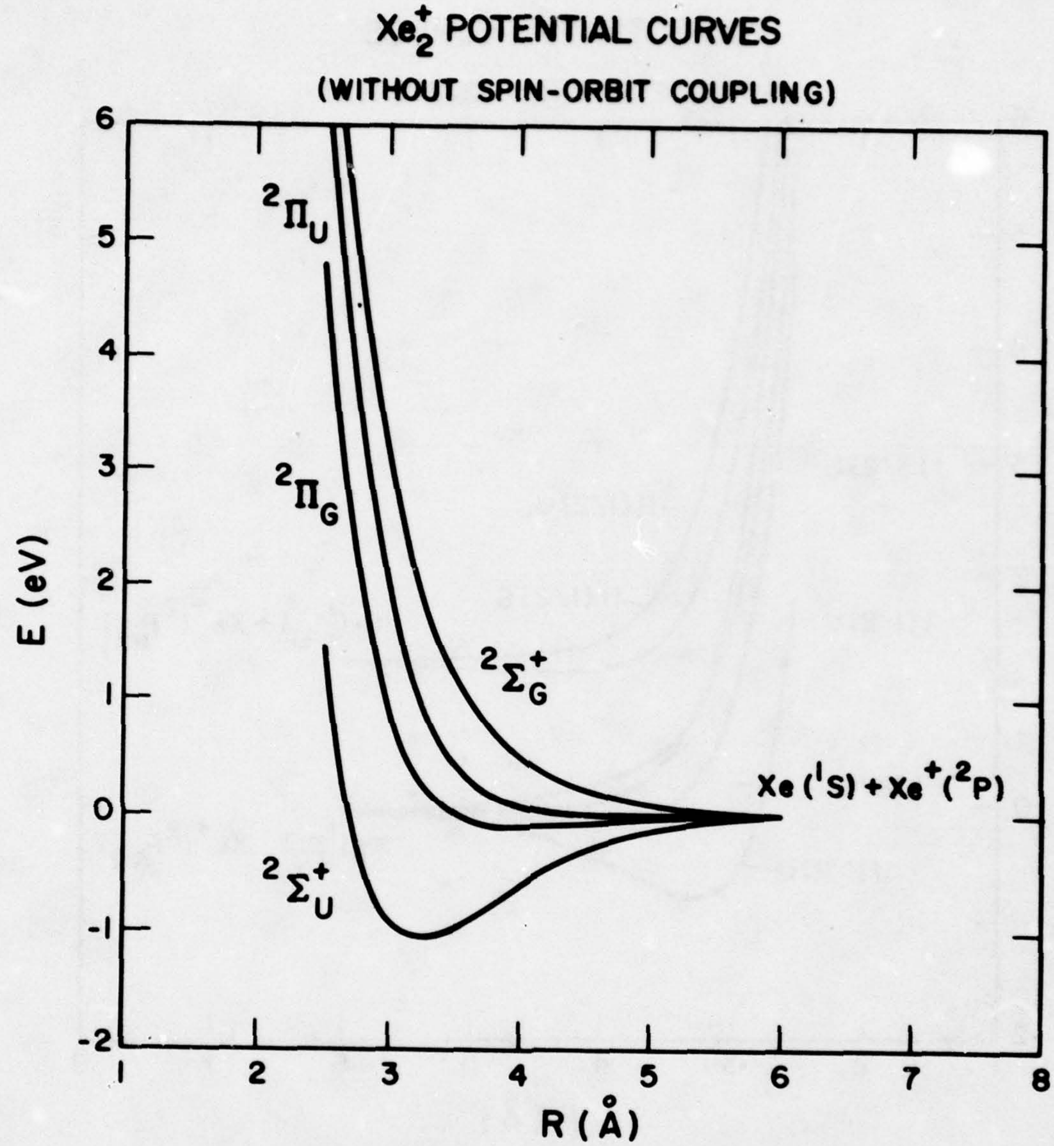
R	I(1/2)u	II(1/2)u	I(3/2)u	I(1/2)g	II(1/2)g	I(3/2)g
20.0 a_o	-.30207	-.27760	-.30207	-.30207	-.27760	-.30207
8.0	-.30813	-.28027	-.30271	-.30007	-.27695	-.30410
7.0	-.31693	-.28098	-.30148	-.29752	-.27262	-.30606
6.75	-.32027	-.28043	-.30042	-.29674	-.26989	-.30649
6.5	-.32404	-.27918	-.29869	-.29583	-.26592	-.30670
6.25	-.32815	-.27689	-.29594	-.29459	-.26022	-.30645
6.0	-.33239	-.27301	-.29165	-.29269	-.25221	-.30539
5.75	-.33636	-.26676	-.28504	-.28957	-.24109	-.30296
5.5	-.33944	-.25702	-.27498	-.28434	-.22581	-.29828
5.25	-.34064	-.24213	-.25981	-.27568	-.20485	-.29006
5.0	-.33842	-.21969	-.23713	-.26160	-.17617	-.27633
4.75	-.33045	-.18627	-.20351	-.23921	-.13689	-.25420
4.25	-.28159	-.06465	-.08158	-.15051	-.00897	-.16588
3.5	.00144	.41154	.39490	.23338	.41471	.21780

Tabular Data A-6.24. Spectroscopic data for the ground state of Kr_2^+ with and without spin-orbit coupling.

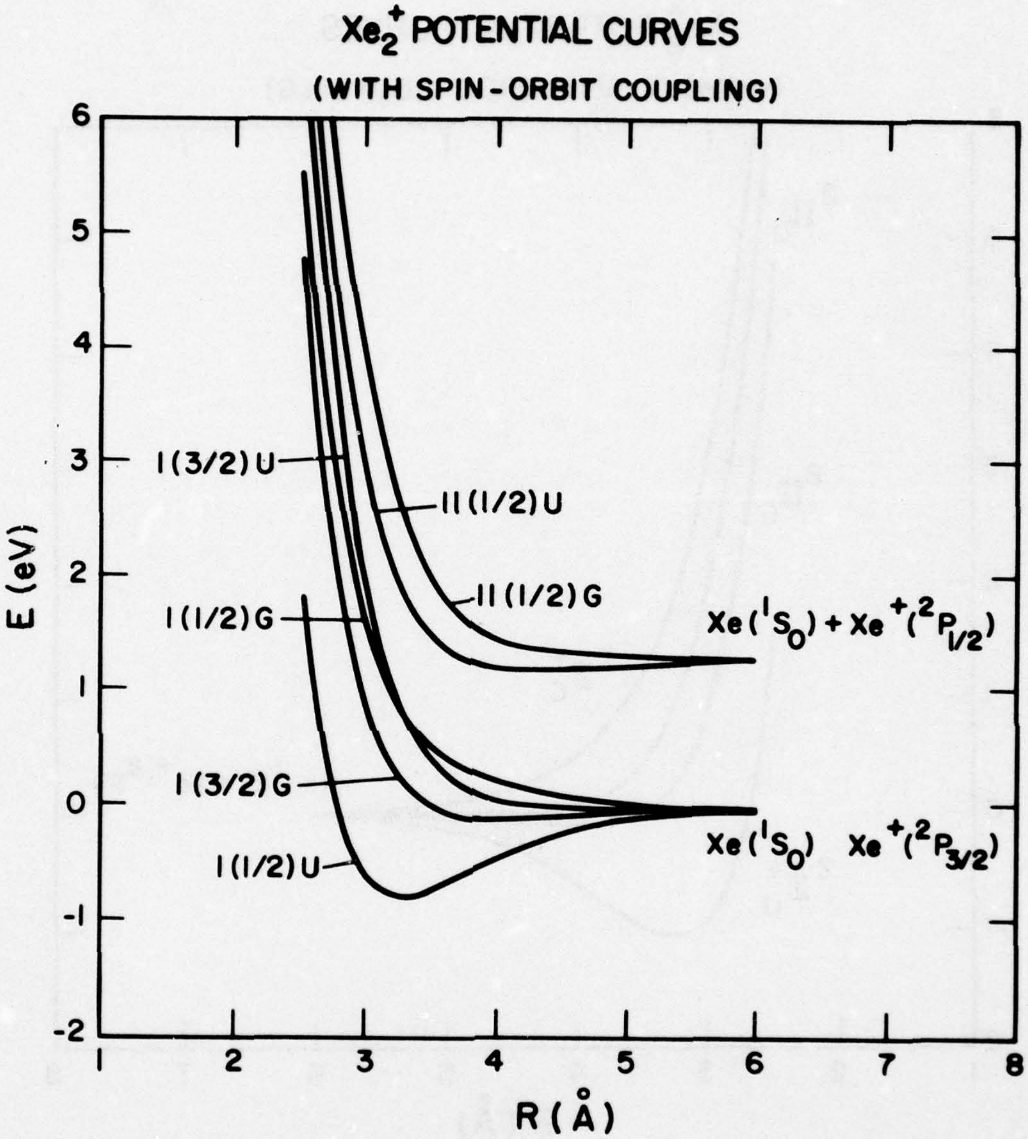
	D_e(eV)	R_e(Å)	ω_e(cm^{-1})	B_e(cm^{-1})
$1^2\Sigma_u^+$	1.23	2.77	183	0.0522
I(1/2)u	1.05	2.79	177	0.0518

Tabular Data A-6.25. Absorption data for Kr_2^+ with and without spin-orbit coupling.

	ΔE(eV)	λ(nm)	M(D)	f
$1^2\Sigma_u^+ \rightarrow 1^2\Pi_g$	1.57	790	0.15	1.3×10^{-4}
$\rightarrow 1^2\Sigma_g^+$	3.59	346	5.39	0.40
I(1/2)u → I(3/2)g	1.36	911	0.10	5.6×10^{-5}
→ I(1/2)g	1.75	708	1.55	1.6×10^{-2}
→ II(1/2)g	3.66	339	5.20	0.38



Graphical Data A-6.26. Xe_2^+



Graphical Data A-6.27. Xe_2^+

Tabular Data A-6.28. Total energies for POL CI calculations on Xe_2^+ without spin-orbit coupling. (Energies are relative to -14463. hartrees)

R	$^2\Sigma_u^+$	$^2\Pi_g$	$^2\Pi_u$	$^2\Sigma_g^+$
20.0 a_o	- 0.18297	- 0.18296	- 0.18296	- 0.18297
10.0	- 0.18666	- 0.18412	- 0.18366	- 0.18161
9.0	- 0.19120	- 0.18513	- 0.18371	- 0.17862
8.0	- 0.20002	- 0.18671	- 0.18269	- 0.17150
7.75	- 0.20305	- 0.18704	- 0.18189	- 0.16847
7.5	- 0.20636	- 0.18721	- 0.18064	- 0.16463
7.25	- 0.20990	- 0.18708	- 0.17871	- 0.15973
7.0	- 0.21353	- 0.18644	- 0.17582	- 0.15342
6.5	- 0.22006	- 0.18222	- 0.16519	- 0.13470
6.25	- 0.22209	- 0.17748	- 0.15600	- 0.12091
6.0	- 0.22238	- 0.16981	- 0.14274	- 0.10287
5.75	- 0.21980	- 0.15783	- 0.12378	- 0.07921
5.5	- 0.21274	- 0.13960	- 0.09684	- 0.04816
5.0	- 0.17478	- 0.07245	- 0.00544	+ 0.04660
4.5	- 0.07427	- 0.06921	+ 0.17314	+ 0.21206

Tabular Data A-6.29. Total energies for POL CI calculations on Xe_2^+ with spin-orbit coupling. (Energies are relative to -14463. hartrees)

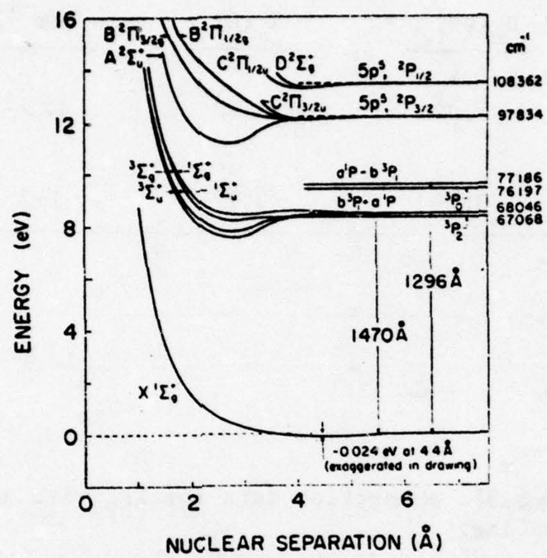
R	I(1/2)u	II(1/2)u	I(3/2)u	I(1/2)g	II(1/2)g	I(3/2)g
20.0	-.19897	-.15096	-.19897	-.19897	-.15096	-.19897
10.0	-.20170	-.15261	-.19966	-.19847	-.15124	-.20012
9.0	-.20495	-.15395	-.19971	-.19699	-.15075	-.20113
8.0	-.21145	-.15524	-.19869	-.19373	-.14847	-.20271
7.75	-.21374	-.15518	-.19789	-.19242	-.14708	-.20304
7.5	-.21627	-.15472	-.19664	-.19078	-.14505	-.20321
7.25	-.21899	-.15361	-.19471	-.18873	-.14207	-.20308
7.0	-.22179	-.15155	-.19182	-.18610	-.13775	-.20244
6.5	-.22666	-.14257	-.18119	-.17803	-.12288	-.19822
6.25	-.22791	-.13417	-.17200	-.17158	-.11080	-.19348
6.0	-.22746	-.12165	-.15874	-.16240	-.09426	-.18581
5.75	-.22419	-.10337	-.13978	-.14915	-.07188	-.17383
5.5	-.21651	-.07706	-.11284	-.12986	-.04189	-.15560
5.0	-.17750	+.01328	-.02144	-.06119	+.05135	-.08845
4.5	-.07620	+.19107	+.15713	+.08129	+.21597	+.05320

Tabular Data A-6.30. Spectroscopic data for the ground state of Xe_2^+ with and without spin-orbit coupling.

	D_e(eV)	R_e(Å)	ω_e(cm^{-1})	B_e(cm^{-1})
$1^2\Sigma_u^+$	1.08	3.22	123	0.0246
I(1/2)u	0.79	3.27	112	0.0239

Tabular Data A-6.31. Absorption data for Xe_2^+ with and without spin-orbit coupling.

	ΔE(eV)	λ(nm)	M(D)	f
$1^2\Sigma_u^+ \rightarrow 1^2\Pi_g$	1.31	948	0.18	1.6×10^{-4}
$\rightarrow 1^2\Sigma_g^+$	3.02	410	5.97	0.41
I(1/2)u → I(3/2)g	0.99	1250	0.12	5.3×10^{-5}
→ I(1/2)g	1.60	775	3.73	8.4×10^{-2}
→ II(1/2)g	3.31	375	4.87	0.30



Estimated potential curves for Xe_2^+ ion correlating with lowest states of $Xe^+ + Xe$, and for lowest states of Xe_2 molecule.

Graphical Data A-6.32. Xe_2^+

Tabular Data A-6.33. Comparison of theoretical and experimental determinations of the dissociation energy for the I(1/2)u states of Ar_2^+, Kr_2^+ and Xe_2^+. (Energies are in eV).

		Photoionization			Rainbow Scattering		
	This Work	a	b	c	d	e	f
Ar_2^+	1.19	1.23	1.049		1.25	1.34	1.3
Kr_2^+	1.05	1.15	0.995	1.13		1.21	
Xe_2^+	0.79	1.03	0.968	0.99	0.97	0.99	

[a] C.Y. Ng, D. J. Trevor, B. H. Mahan and Y. T. Lee, J. Chem. Phys. 66, 446, (1977).

[b] M. S. Munson, J. L. Franklin and F. H. Field, J. Phys. Chem. 67, 1542, (1963).

[c] C. E. Melton and W. H. Hamill, J. Chem. Phys. 41, 1469, (1964).

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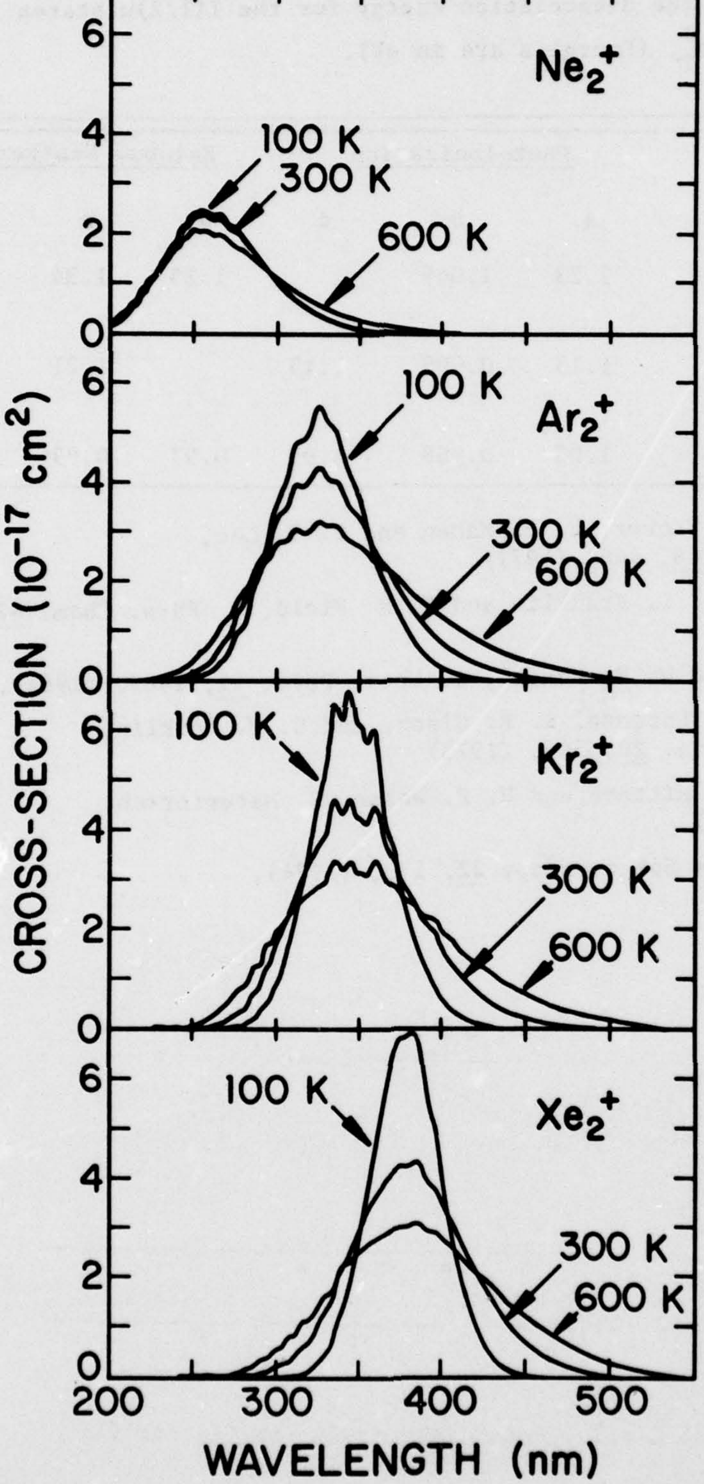
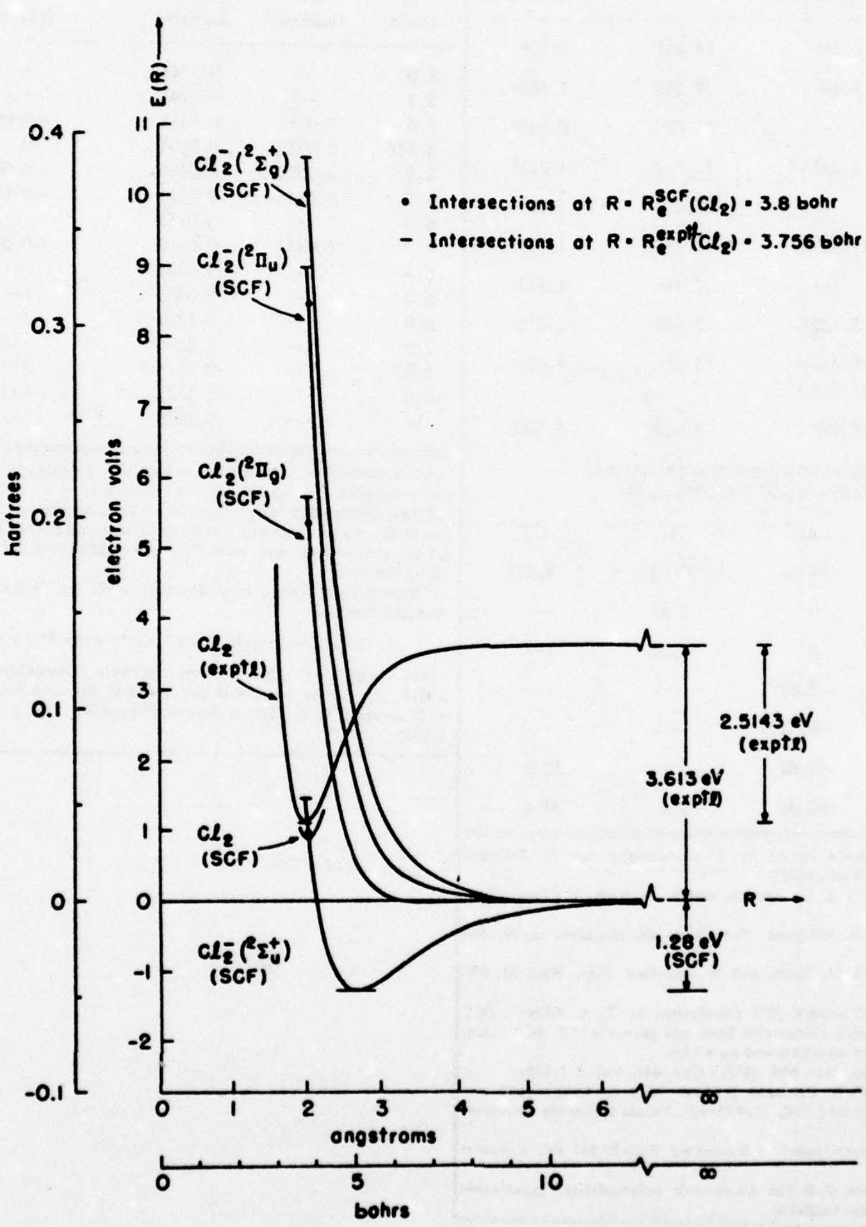
[e] Reference H. V. Mittman and H. P. Weise, Z. Naturforsch, 29a, 400, (1974).

[f] T. Arikawa, Mass Spectroscopy 22, 173, (1974).



Graphical Data A-6.34. The absorption spectra for the $I(1/2)_u \rightarrow II(1/2)_g$ transition in Ne_2^+, Ar_2^+, Kr_2^+ and Xe_2^+ determined from ab initio configuration interaction calculations.



Graphical Data A-6.35. Potential curves for $C\ell_2$ and $C\ell_2^-$.

Tabular Data A-6.36. Energy parameters

Asymptotic parameters.

A. Atomic parameters for asymptotic interactions

	α ($bohr^3$)	I (eV)	$\langle r^2 \rangle_{nl}$ ($bohr^2$)
He^+	0.281[a]	54.403[f]	0.75[h]
He	1.40[b]	24.581[f]	1.185[h]
Ne^+	...	41.07[f]	0.982[h]
Ne	2.663[c]	21.559[f]	1.228[h]
Ar^+	...	27.62[f]	2.860[h]
Ar	11.08[b]	15.755[f]	3.309[f]
F	...	17.418[f]	1.543[h]
F^-	5.122[d]	3.448[g]	2.210[h]
Cl	10.4(σ)[e] 11.0(π)[e]	13.01[f]	4.058[h]
Cl^-	20.07[d]	3.613[g]	5.108[h]

B. Asymptotic expansion parameters[i]

$U(R) = A_3/R^3 + A_4/R^4 + A_6/R^6$

	A_3	A_4	C [j]
He_2^+	0	0.70	0.367
Ne_2^+	0	1.33	...
Ar_2^+	0	5.54	...
F_2^- Σ	−0.62	...	...
Π	+0.31	...	...
Cl_2^- Σ	−1.62	5.1	32.5
Π	+0.81	5.5	34.4

[a] *Handbook of Physics*, edited by E. U. Condon and H. Odishaw McGraw-Hill, New York, 1967).
[b] D. R. Johnston, G. J. Oudermans, and R. H. Cole, J. Chem. Phys. 33, 1310 (1960).
[c] A. Dalgarno and A. Kingston, Proc. Roy. Soc. (London) A259, 424 1960).
[d] J. R. Tessman, A. H. Kahn, and W. Shockley, Phys. Rev. 92, 870 1953).
[e] From unpublished atomic SCF calculations by T. L. Gilbert. SCF calculations for Cl^- with comparable basis sets gave $\alpha = 17.7$. SCF calculations for $Cl^{-1/2}$ gave $\alpha_\sigma = 13.6$ and $\alpha_\pi = 13.9$.
[f] C. E. Moore, Natl. Bur. Std. (U.S.) Circ. 467, Vol. 3 (1958).
[g] R. S. Berry and C. W. Reimann, J. Chem. Phys. 38, 1540 (1963).
[h] P. S. Bagus, Phys. Rev. 139, A619 (1965). Values are for the outermost occupied orbital.
[i] All units are hartree·$bohr^n$. 1 hartree = 2 Ry = 27.212 eV, 1 bohr = 0.529177 Å.
[j] $A_6 = C + \frac{3}{4}\beta$, where β is the quadrupole polarizability. Quadrupole polarizabilities are not available.

Potential curves for Cl_2.

R (bohr)	$U(R) = E_{Cl_2}(R) - E_{Cl_2^-}(\infty)$ SCF [b] (hartree)	Exptl[c] (hartree)	$U_{SCF}(R) - U_{exptl}(R) + \delta U$ [a] (hartree)
3.0	...	0.1744	...
3.3	...	0.0741	...
3.6	0.0381	0.0433	−0.0019
3.756	0.0333_4	0.0404	0
3.8	0.0332_8	0.0406	−0.0002
3.9	0.0346	0.0423	−0.0006
4.0	...	0.0453	...
4.2	0.0477	0.0542	+0.0006
4.5	...	0.0703	...
5.0	...	0.0952	...
6.0	...	0.1219	...
7.0	...	0.1296	...
8.0	...	0.1316	...
9.0	...	0.1328	...
∞	...	0.1328	...

[a] The comparison was adjusted so that the experimental and calculated curves coincide at $R = 3.756$ bohr by choosing $\delta U = +0.0071$ hartree.
[b] The limiting SCF value $E_{Cl_2^-}(\infty) = 2E_{Cl^{-1/2}}$ was used. The calculation of $E_{Cl^{-1/2}}$ was done with a heteropolar diatomic program which allowed orbital polarization, and gave $E_{Cl^{-1/2}} = -459.51018$ for an optimized (5, 4) basis set.
[c] Experimental values were obtained using the Hulbert-Hirschfelder potential function

$$E_{Cl_2}(R) - E_{Cl_2}(R_e) = D[(1-e^{-x})^2 + cx^3e^{-2x}(1+bx)],$$

where $x = 2\beta(R-R_e)/R_e$, with the constants $D = 0.09240$ hartree, $2\beta = 3.9779$, $R_e = 3.7564$, $c = 0.1463$ and $b = 1.054$ obtained from the data of A. E. Douglas, C. K. Moeller, and B. P. Stoicheff, Can. J. Phys. 41, 1174 (1963).

Tabular Data A-6.37. Energy level difference parameters for He_2^+

Energy level difference parameters for He_2^+: $\Delta E(R) \equiv E_{\Sigma_g^+}(R) - E_{\Sigma_u^+}(R) = A \exp(-\alpha R)$.

Method[a]	Range[b]	A (eV)	α (bohr^{-1})	Fitting error[c] (%)	Comparison[d] (%) 50 eV	15 eV	10 eV
SCF	$1.5 \le R \le 3$ bohr	128.8	1.237	0.3	11.2	3.1	7.6
SCF	$3.0 \le R \le 6$ bohr	175.1	1.329	2.1	7.8	6.9	10.2
FO	$1.5 \le R \le 3$ bohr	137.8	1.267	0.4	11.2	3.1	7.2
FO	$3.0 \le R \le 6$ bohr	133.3	1.251	0.9	12.2	4.5	19.2
MC[e]	$1.5 \le R \le 3$ bohr	127.4	1.242	0.9	8.7	1.0	5.4
MC[e]	$3.0 \le R \le 6$ bohr	134.4	1.261	4.3	8.2	0.8	14.8
EXP[f]	50 eV	120.4	1.254	...	0	7.0	6.1
EXP[g]	15 eV	130.5	1.256	...	7.0	0	10.3
EXP[g]	10 eV	137.0	1.295	...	6.1	10.3	0

[a] SCF: $E_\lambda(R)$ = total SCF energy of molecule-ion. FO: $E_\lambda(R) = E_0(R) - \epsilon_\lambda(R)$, where E_0 is the total energy of the closed-shell species and ϵ_λ is the orbital energy of the electron removed to form a molecule-ion in the λ state. MC: E_λ obtained from multiconfiguration calculations. EXP: parameters obtained from elastic differential scattering data.

[b] The values of the internuclear distance for which the fit was made are given for the calculated parameters. The incident energy (in the center-of-mass reference frame) is given for parameters obtained from scattering data.

[c] Fitting error $= 100(n^{-1} \sum_{i=1}^{n} \{[\Delta E_i - A \exp(-\alpha R_i)]/\Delta E_i\}^2)^{1/2}$,

where ΔE_i are the calculated energy level differences.

[d] Comparison

$$= 100((R_b - R_a)^{-1} \int_{R_a}^{R_b} \{(A_1/A_2) \exp[-(\alpha_1 - \alpha_2)R] - 1\}^2 dR)^{1/2},$$

where R_a and R_b are the limits of the range and (A_1, α_1) and (A_2, α_2) are the parameters for the two cases compared. The range was taken to be $1.5 \le R \le 6$ bohr for comparison of the experimental parameters at different scattering energies. The columns labeled 50, 15, and 10 eV give comparisons with the experimental parameters for each of these three incident energies.

[e] P. N. Reagan, J. C. Browne, and F. A. Matsen, Phys. Rev. 132, 304 (1963) ($E_{\Sigma_u^+}$); J. C. Browne, J. Chem. Phys. 45, 2707 (1966) ($E_{\Sigma_g^+}$).

[f] J. C. Y. Chen, C.-S. Wang, and K. M. Watson, Phys. Rev. A1, 1150 (1970).

[g] R. E. Olson and C. R. Mueller, J. Chem. Phys. 46, 3810 (1967).

Tabular Data A-6.38. Energy level difference parameters for Ne_2^+, Ar_2^+, F_2^-, amd $C\ell_2^-$

Energy level difference parameters for Ne_2^+, Ar_2^+, F_2^-, and Cl_2^-: $\Delta E(R) = A \exp(-\alpha R)$.[a]

Species	Symmetry	Method[b]	Range[c] (bohr)	A (eV)	α ($bohr^{-1}$)	Fitting error[d] (%)
Ne_2^+	Σ	SCF	$3.0 \leq R \leq 3.5$	231.1	1.171	0.02
		FO	$3.0 \leq R \leq 3.5$	238.3	1.204	0.03
		FO	$2.5 \leq R \leq 6.0$	249.8	1.218	0.7
		EXP[e]	$1.2 \leq R \leq 1.6$	240	1.6	20
	Π	SCF	$3.0 \leq R \leq 3.5$	183.3	1.531	0.05
		FO	$3.0 \leq R \leq 3.5$	175.4	1.532	0.1
		FO	$2.5 \leq R \leq 6.0$	152.8	1.485	2.4
		EXP[e]	$1.2 \leq R \leq 1.6$	160	2.0	15
		EXP[f]	$1.0 \leq R \leq 1.8$	230	2.3	...
		EXP[g]	$0.4 \leq R \leq 1.5$	390	2.4	...
Ar_2^+	Σ	SCF	$4.2 \leq R \leq 5.0$	234.3	0.865	0.2
		FO	$4.2 \leq R \leq 5.0$	243.7	0.883	0.2
		FO	$3.0 \leq R \leq 5.0$	199.1	0.838	1.7
		EXP	...	...	...	...
	Π	SCF	$4.2 \leq R \leq 5.0$	206.6	1.157	0.1
		FO	$4.2 \leq R \leq 5.0$	208.9	1.160	0.1
		FO	$3.0 \leq R \leq 5.0$	218.9	1.170	0.3
		EXP[f]	$1.8 \leq R \leq 2.7$	490	1.8	...
F_2^-	Σ	SCF	$3.2 \leq R \leq 4.0$	132.8	0.924	0.4
	Π	SCF	$3.2 \leq R \leq 4.0$	84.2	1.122	0.3
Cl_2^-	Σ	SCF	$3.8 \leq R \leq 6.0$	136.0	0.712	0.2
	Π	SCF	$3.8 \leq R \leq 6.0$	93.8	0.897	0.7

[a] $\Delta E(R) = E_{\Sigma_g^+}(R) - E_{\Sigma_u^+}(R)$ for Σ states; $\Delta E(R) = E_{\Pi_u}(R) - E_{\Pi_g}(R)$ for Π states.

[b] SCF: $E_\lambda(R)$ = total SCF energy of molecule ion. FO: $E_\lambda(R) = E_0(R) - \epsilon_\lambda(R)$, where E_0 is the total energy of the closed-shell species and ϵ_λ is the orbital energy of the electron removed to form a molecule-ion in the state λ. EXP: parameters obtained from resonant electron capture data.

[c] Limiting values of the internuclear distance for which the fit was made.

[d] Fitting error $= 100(n^{-1} \sum_{i=1}^{n} \{[\Delta E_i - A \exp(-\alpha R_i)]/\Delta E_i\}^2)^{1/2}$, where ΔE_i are the calculated energy level differences. The entries for experimental values (where given) are the experimental uncertainties.

[e] P. R. Jones, T. L. Batra, and H. A. Ranga, Phys. Rev. Letters 17, 281 (1966).

[f] P. R. Jones, N. W. Eddy, H. P. Gilman, A. K. Jhaveri, and G. Van Dyk, Phys. Rev. 147, 76 (1966).

[g] P. R. Jones, P. Costigan, and G. Van Dyk, Phys. Rev. 129, 211 (1963). This analysis was carried out under the assumption that the effect of the Σ states could be ignored.

A-7. POTENTIAL ENERGY CURVES AND OTHER DATA FOR RARE-GAS EXCIMERS AND FOR UNLIKE PAIRS OF RARE-GAS ATOMS

CONTENTS

Page

A-7. References

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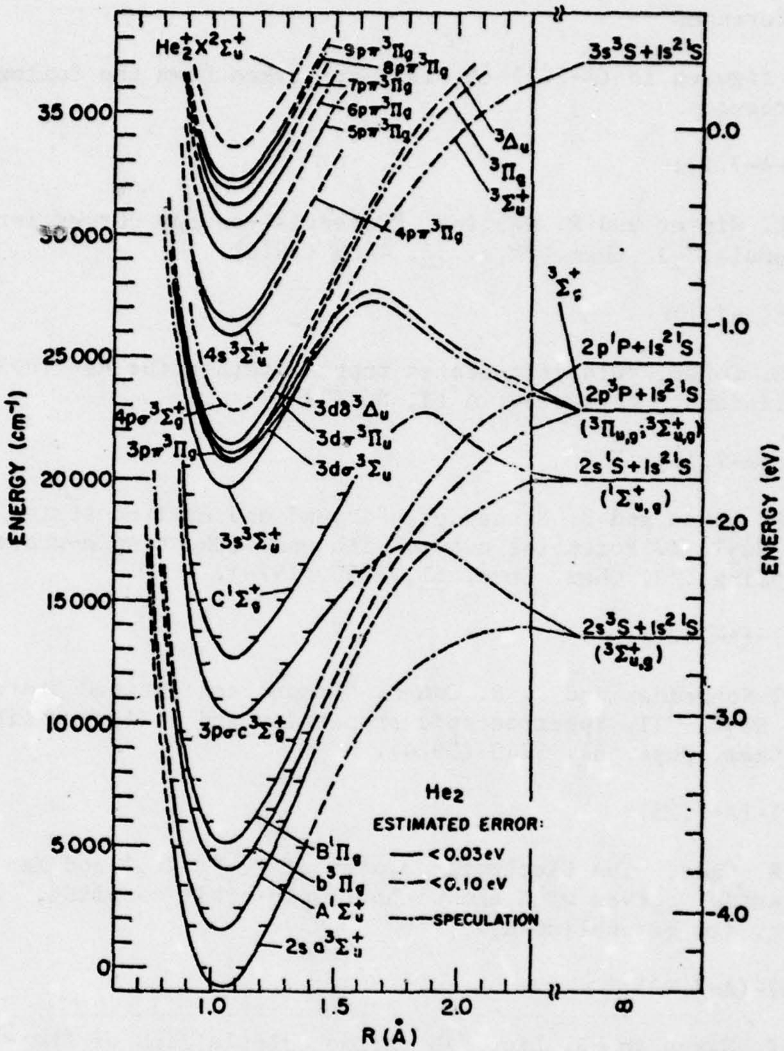
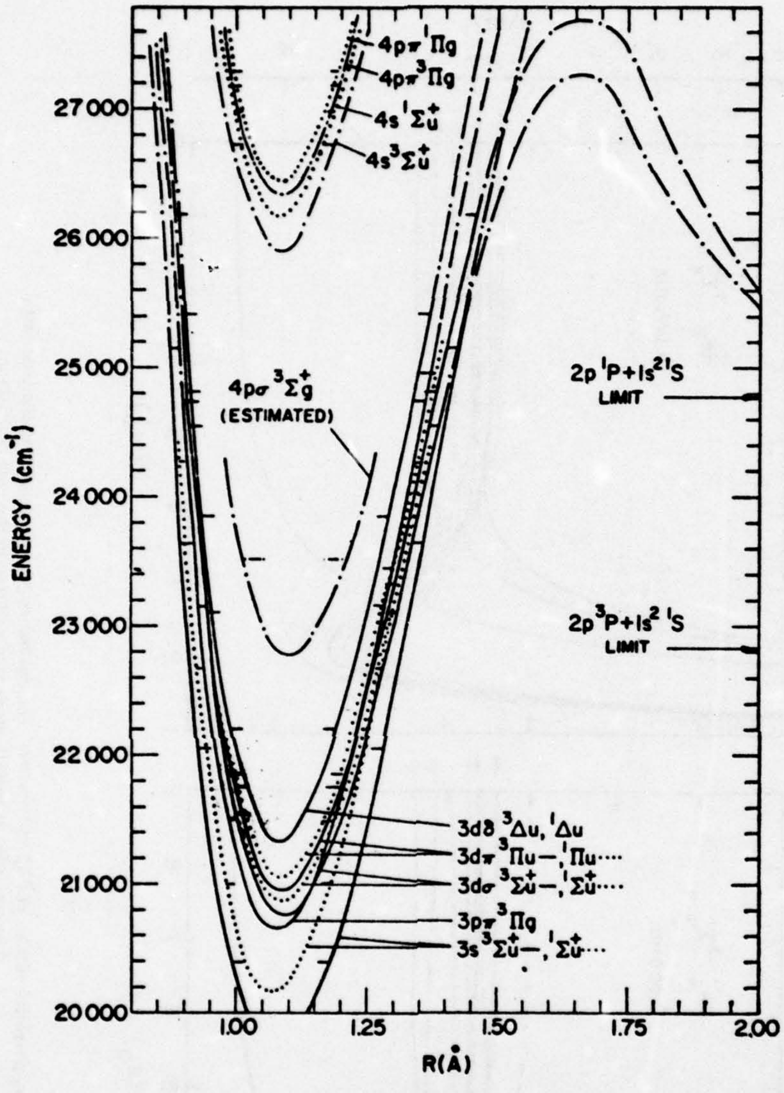
(A-7.31)-(A-7.33):

J. S. Cohen and R. T. Pack, "Modified statistical method for intermolecular potentials. Combining rules for higher van der Waals coefficients," J. Chem. Phys. 61, 2372 (1974).



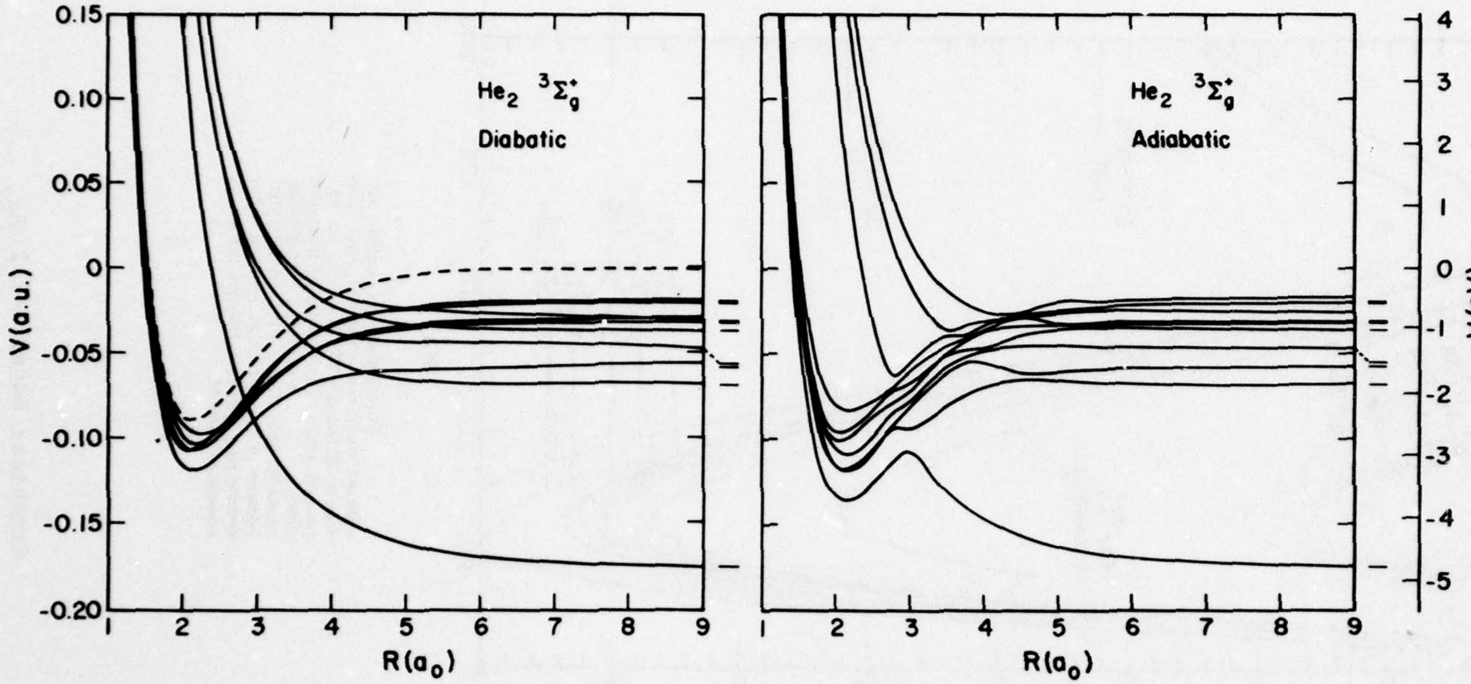
Potential-energy curves (rotationless) for selected electronic states of He_2. Energy in cm^{-1} is based on N=0, ν=0 of the $a^3\Sigma_u{}^+$ state, while energy in electron volts is based on the lowest level in $X^2\Sigma_u{}^+$ of $He_2{}^+$. When practical, the observed vibrational levels are indicated by horizontal lines at the edges of their appropriate curves.

Graphical Data. A-7.1. He_2



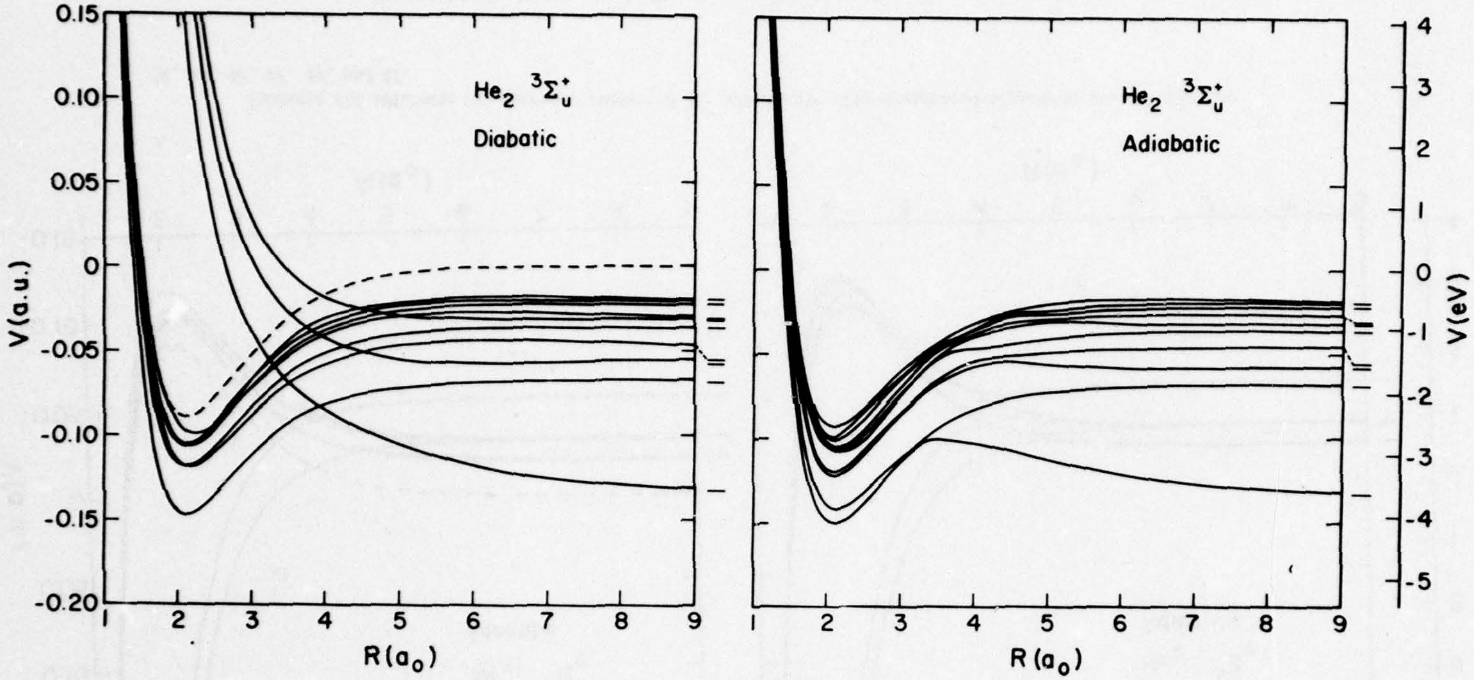
Potential-energy curves for selected electronic states of He_2: The region 20 000–28 000 cm^{-1} on an expanded scale. The comments from the caption also apply. The potential curve for $3p\pi\ ^1\Pi_g$ has not been presented because of the confusion resulting from overlapping by the curves for the states associated with $3d$.

Graphical Data. A-7.2. He_2



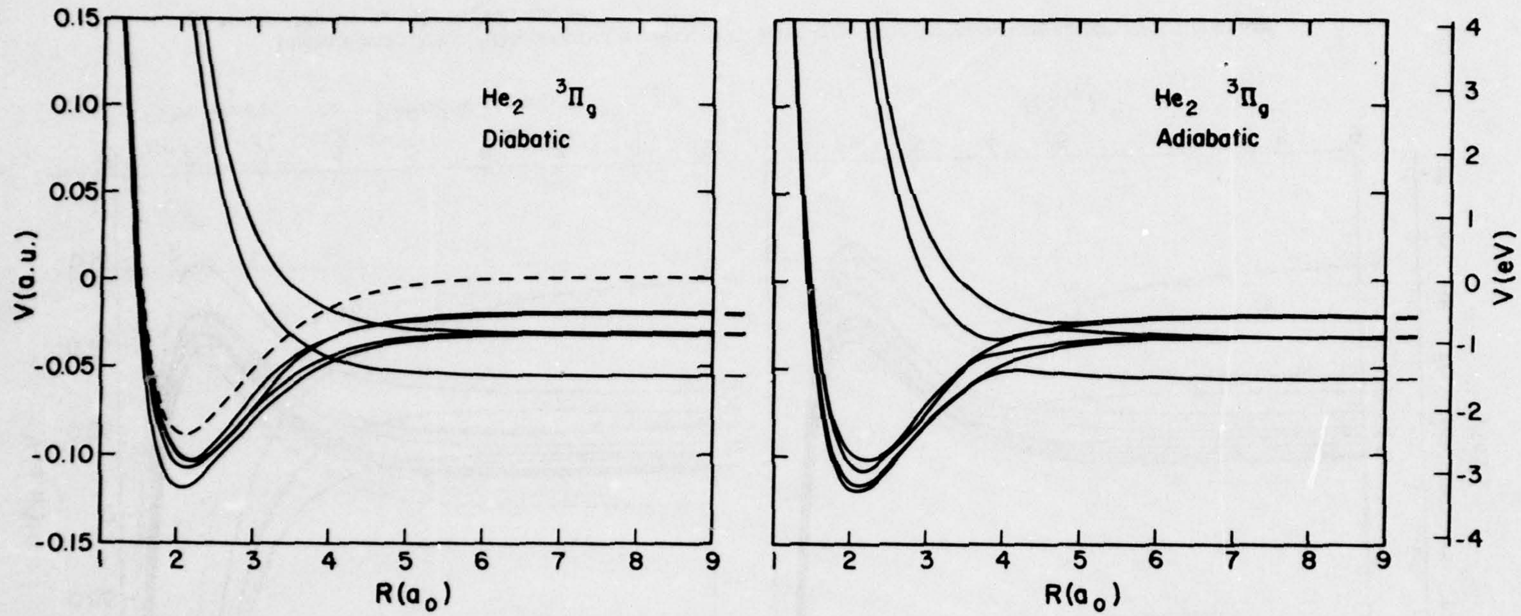
Diabatic and adiabatic He_2 potential curves of $^3\Sigma_g^+$ symmetry. The dashed curve, representing the continuum limit, is the ground state of He_2^+. The potential energy is measured relative to the separated-atom energy of $He^+ + He$. The designated separated-atom limits are 2*s*, 3*s*, 3*p*, 3*d*, 4*s*, 4*p*, 4*d*, 4*f*, 5*p*, and 5*f*.

Graphical Data A-7.3. He_2 potential curves of $^3\Sigma_g^+$ symmetry.



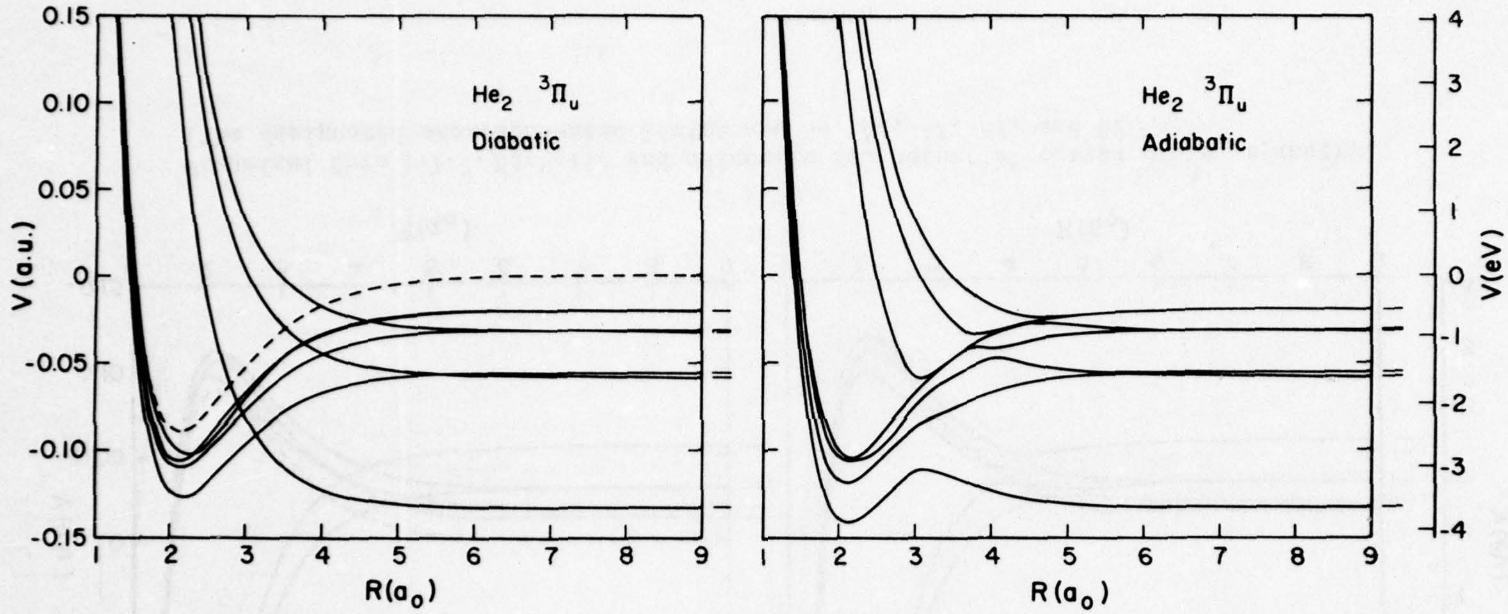
Diabatic and adiabatic He_2 potential curves of $^3\Sigma_u^+$ symmetry. The designated separated-atom limits are *2p*, *3s*, *3p*, *3d*, *4s*, *4p*, *4d*, *5s*, *5d*, and *5g*.

Graphical Data A-7.4. He_2 potential curves of $^3\Sigma_u^+$ symmetry.

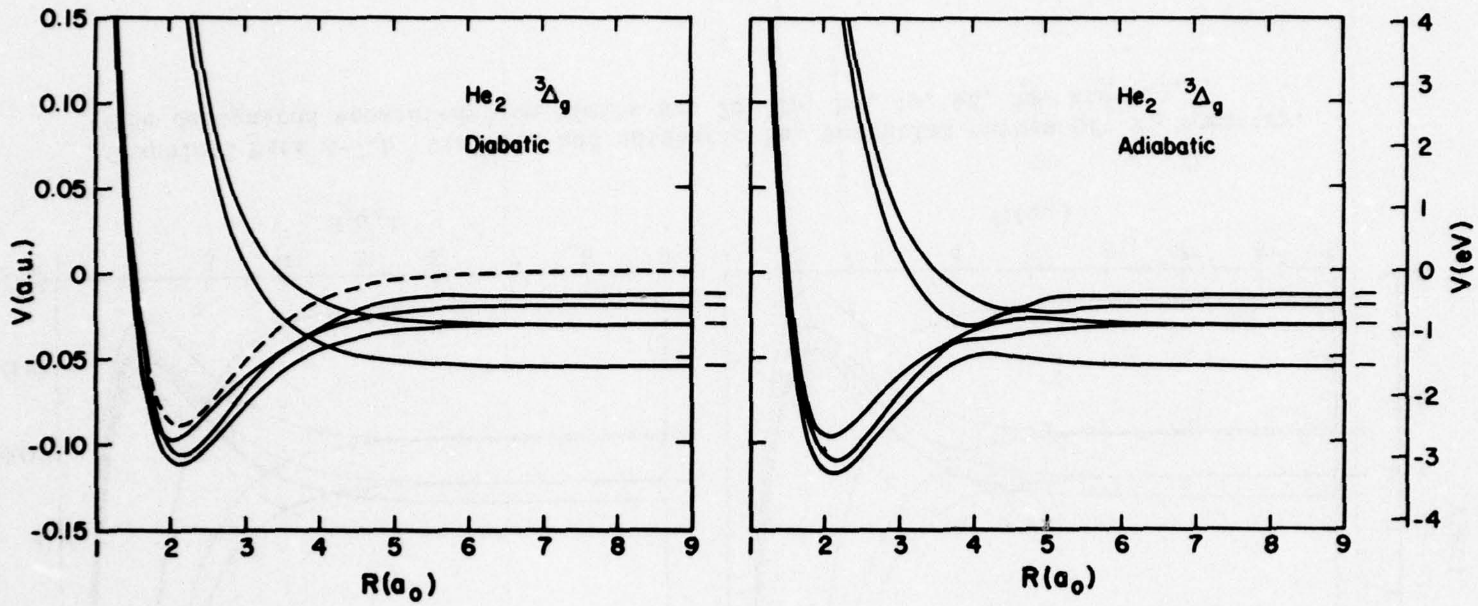


Diabatic and adiabatic He_2 potential curves of $^3\Pi_g$ symmetry. The designated separated-atom limits are *3d*, *4p*, *4d*, *4f*, *5p*, and *5f*.

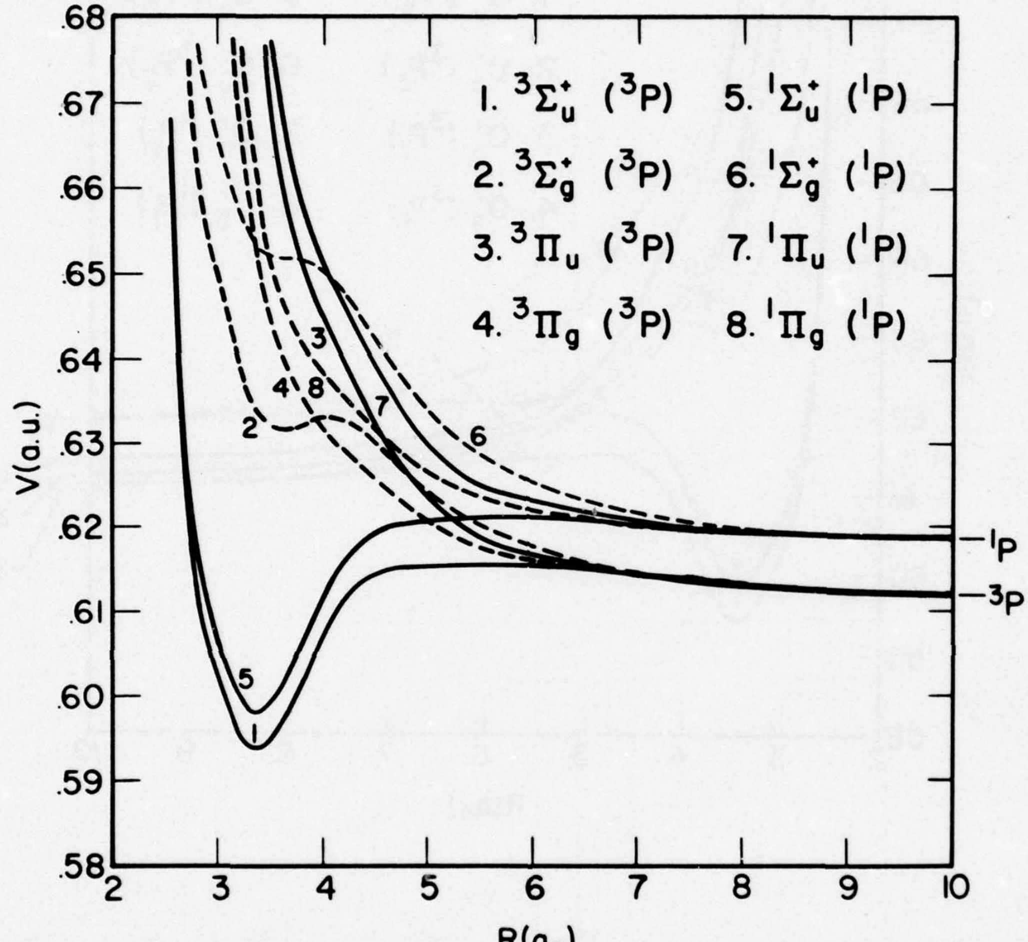
Graphical Data A-7.5. He_2 potential curves at $^3\Pi_g$ symmetry.



Graphical Data A-7.6. Diabatic and adiabatic He_2 potential curves of $^3\pi_u$ symmetry. (The designated separated-atom limits are 2p, 3p, 3d, 4p, 4d, 5d, and 5g).

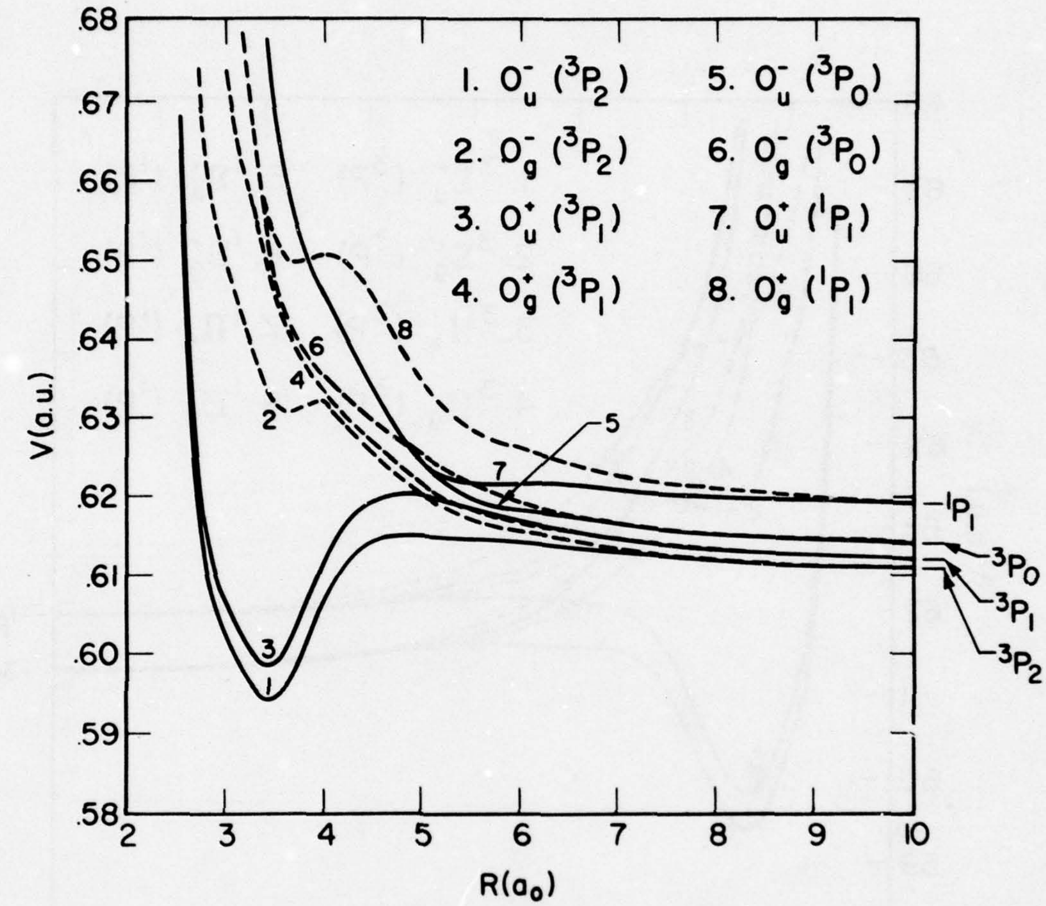


Graphical Data A-7.7. Diabatic and adiabatic He_2 potential curves of $^3\Delta_g$ symmetry. (The designated separated-atom limits are 3d, 4d, 4f, 5f, and 6f).

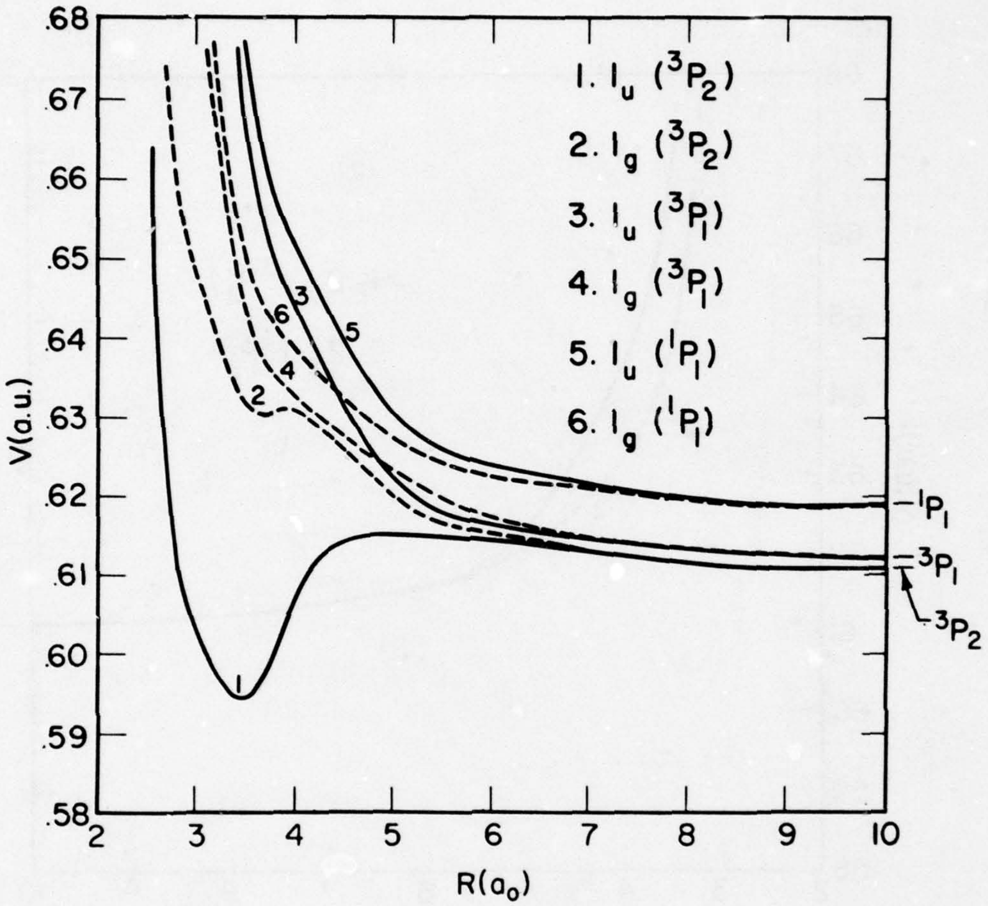


Potential curves for the excited states of Ne_2 formed in the interaction of Ne(3s, $^{1,3}P$) with ground-state Ne, not including spin-orbit coupling. The zero of the energy scale is the separated-atom limit of ground-state Ne_2.

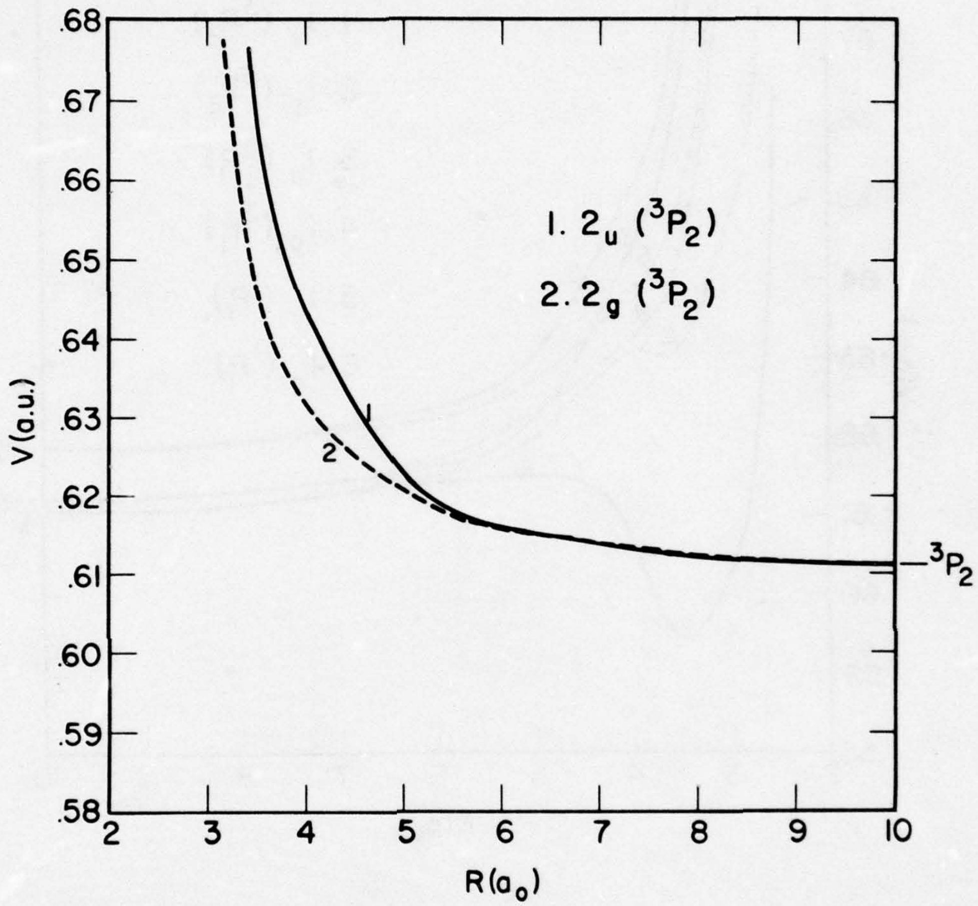
Graphical Data. A-7.8.



Graphical Data A-7.9. Potential curves of excited states of Ne_2 with Ω=0, including the effects of spin-orbit coupling.



Graphical Data A-7.10. Potential curves of excited states of Ne_2 with Ω=1, including the effects of spin-orbit coupling.



Graphical Data A-7.11. Potential curves of excited states of Ne_2 with Ω=2, including the effects of spin-orbit coupling.

Tabular Data A-7.12. Ground-state energies of Ne_2.

$R[a_o]$	Present[a]	GW[b]	FSL[c]
2.5	0.3353	0.3305	0.2684
3.0	0.0927	0.0973	0.0931
3.25	0.0488		0.0541
3.5	0.0256	0.0287	0.0305
3.75	0.0134		0.0164
4.0	0.0070	0.0084	0.0083
4.5	0.0018		0.0017
5.0	4.4×10^{-4}	0.0007	2.0×10^{-4}
6.0	0		-1.3×10^{-4}
8.0	-3.1×10^{-6}		-2.9×10^{-5}

[a] All energies in a.u.

[b] From Ref. T. L. Gilbert and A. C. Wahl, J. Chem. Phys. 47, 3425, (1967).

[c] Evaluated from the exponential - spline - Morse - spline - van der Waals parameters given in J. M. Farrar, T. P. Shafer and Y. T. Lee, in Transport Phenomena, AIP Conference Proceedings No. 11, edited by J. Kestin (AIP, New York, 1973) p. 279.

Tabular Data A-7.13. Potential energies (relative to the separated-atom limit) of Ne_2^* before spin-orbit coupling.[a]

$R[a_o]$	V(R) [a.u.]							
	$^3\Sigma_u^+$	$^3\Sigma_g^+$	$^1\Sigma_u^+$	$^1\Sigma_g^+$	$^3\Pi_u$	$^3\Pi_g$	$^1\Pi_u$	$^1\Pi_g$
2.5	0.07221	0.12457	0.06939	0.14536	0.40036	0.29441	0.39844	0.29355
3.0	-0.00934	0.03639	-0.01217	0.04913	0.13607	0.09084	0.13492	0.09019
3.25	-0.01701	0.02485	-0.01968	0.03793				
3.5	-0.01760	0.02000	-0.02000	0.03362	0.05482	0.03321	0.05389	0.03296
3.75	-0.01222	0.01992	-0.01441	0.03319				
4.0	-0.00543	0.02098	-0.00744	0.03195	0.03139	0.02059	0.03156	0.01981
4.5	0.00204	0.01782	0.00044	0.02391				
5.0	0.00302	0.01214	0.00186	0.01554	0.01059	0.00859	0.01124	0.00795
5.5	0.00318		0.00236					
6.0	0.00257	0.00559	0.00197	0.00701	0.00447	0.00412	0.00512	0.00365
8.0	0.00058	0.00077	0.00033	0.00114	0.00071	0.00069	0.00100	0.00048

[a]The energies of the excited separated-atom states relative to ground-state $Ne(^1S)$ are $E(^3P) = 0.61192$ a. u. and $E(^1P) = 0.61870$ a.u.

Tabular Data A-7.14. Potential energies of excited Ne_2 including spin-orbit effects.[a]

$R[a_0]$	V(R) [a.u.]													
	$0_u^-(^3P_2)$	$0_g^-(^3P_2)$	$0_u^+(^3P_1)$	$0_g^+(^3P_1)$	$0_u^-(^3P_0)$	$0_g^-(^3P_0)$	$0_u^+(^1P_1)$	$0_g^+(^1P_1)$	$1_u(^3P_2)$	$1_g(^3P_2)$	$1_u(^3P_1)$	$1_g(^3P_1)$	$1_u(^1P_1)$	$1_g(^1P_1)$
2.5	0.07338	0.12573	0.07544	0.15140	0.39919	0.29325	0.39431	0.28837	0.07338	0.12573	0.39937	0.29347	0.39826	0.29333
3.0	-0.00818	0.03752	-0.00613	0.05511	0.13491	0.08971	0.13003	0.08486	-0.00818	0.03752	0.13512	0.08992	0.13471	0.08998
3.25	-0.01586		-0.01366						-0.01586					
3.5	-0.01646	0.02101	-0.01398	0.03324	0.05368	0.03222	0.04880	0.03359	-0.01646	0.02104	0.05388	0.03235	0.05368	0.03280
3.75	-0.01109		-0.00842						-0.01109					
4.0	-0.00432	0.02084	-0.00147	0.02089	0.03084	0.02073	0.02598	0.03165	-0.00432	0.02077	0.03104	0.02072	0.03136	0.01989
4.5	0.00307		0.00630						0.00309					
5.0	0.00389	0.01009	0.00720	0.00883	0.00972	0.01064	0.00525	0.01530	0.00396	0.00931	0.00981	0.01108	0.01108	0.00829
5.5	0.00378		0.00566						0.00390					
6.0	0.00302	0.00495	0.00421	0.00426	0.00402	0.00476	0.00224	0.00687	0.00315	0.00461	0.00398	0.00499	0.00503	0.00376
8.0	0.00062	0.00074	0.00068	0.00072	0.00066	0.00072	0.00036	0.00111	0.00064	0.00073	0.00067	0.00071	0.00097	0.00050

[a] The energies of the excited separated-atom states relative to ground-state $Ne(^1S)$ are as follows: $E(^3P_2) = 0.61074$ a.u., $E(^3P_1) = 0.61265$ a.u., $E(^3P_0) = 0.61428$ a.u., and $E(^1P_1) = 0.61916$ a.u.

Tabular Data A-7.15. Equilibrium postition, R_e, dissociation energy, D_e, position of potential maximum, R_{max}, height of barrier, V_{max}, and $D_e + V_{max}$ for all the true bound states (excluding states bound by dispersion forces only).

State	$R_e[a_o]$	$D_e[eV]$	$R_{max}[a_o]$	$V_{max}[eV]$	$D_e+V_{max}[eV]$
$Ne_2^*\ {}^3\Sigma_u^+\ ({}^3P)$	3.39	0.499	5.4	0.087	0.586
$Ne_2^*\ {}^1\Sigma_u^+\ ({}^1P)$	3.38	0.567	5.5	0.064	0.631
$Ne_2^*\ 0_u^-\ ({}^3P_2)$	3.39	0.467	4.9	0.107	0.573
$Ne_2^*\ 1_u({}^3P_2)$	3.39	0.467	4.9	0.108	0.575
$Ne_2^*\ 0_u^+({}^3P_1)$	3.38	0.403	4.8	0.198	0.601
$Ne_2^*\ 0_u^+\ ({}^1P_1)$	$\sim$5.1	0.016	$\sim$5.5	$\sim$0.060	
$Ne_2^+\ {}^2\Sigma_u^+\ ({}^2P)$	3.30	1.20	-	-	
$Ne_2^+\ (1/2)_u\ ({}^2P_{3/2})$	3.30	1.17	-	-	

Tabular Data A-7.16.

(a) Polarizibilities of ${}^{1,3}P_J$ states of atomic neon; α_{adj} has been adjusted by a one-electron sum rule.

State	$\alpha[10^{-24}\ cm^3]$	α_{adj}	α_{exp}
$Ne(^1S_0)$			0.3946[a]
$Ne(^3P_2)$	23.3	28.3	27.6[b]
$Ne(^3P_1)$	25.3	29.2	
$Ne(^3P_0)$	28.8	29.2	
$Ne(^1P_1)$	31.2	33.4	

[a]Ref: R. R. Teachout and R. T. Pack, At. Data 3, 195 (1971)
[b]Ref: E. J. Robinson, J. Levine, and B. Bederson, Phys. Rev 146, 95 (1966).

(b) Matrix of van der Waals C_6 coefficients (in a.u.) determined using adjusted polarizibilities.

	$^1S_0$	$^3P_2$	$^3P_1$	$^3P_0$	$^1P_1$
$^1S_0$	-7.98[a]				
$^3P_2$	-52.7	-1980			
$^3P_1$	-53.5	-2027	-2075		
$^3P_0$	-53.5	-2027	-2075	-2075	
$^1P_1$	-57.4	-2240	-2294	-2294	-2538

[a]A value -6.55 ± 0.87 is given by G. Starkschall and R. G. Gordon, J. Chem. Phys. 54, 663 (1971).

Tabular Data A-7.17. Vibrational levels of $Ne_2\ {}^3\Sigma_u^+$. (Franck-Condon overlaps with the vibrational levels of the ground state are also given). (The levels below the dashed line are resonant states above the dissociation limit).

v	G[cm^{-1}]	B_v[cm^{-1}]	Franck-Condon Factors v→0	v→1
0	285	0.523	3.2×10^{-17}	3.7×10^{-17}
1	843	0.521	1.5×10^{-15}	1.7×10^{-15}
2	1373	0.520	3.7×10^{-14}	4.2×10^{-14}
3	1870	0.521	6.1×10^{-13}	6.9×10^{-13}
4	2333	0.521	8.1×10^{-12}	9.1×10^{-12}
5	2769	0.518	9.7×10^{-11}	1.1×10^{-10}
6	3183	0.508	1.2×10^{-9}	1.3×10^{-9}
7	3576	0.492	1.5×10^{-8}	1.6×10^{-8}
8	3943	0.473	2.3×10^{-7}	2.4×10^{-7}
9	4274	0.448	4.9×10^{-6}	4.8×10^{-6}
10	4553	0.406	3.3×10^{-4}	2.6×10^{-4}

$D_e = 4020\ cm^{-1}$

$V_{max} = 700\ cm^{-1}$

$R_e = 1.79 \times 10^{-8}\ cm$

Tabular Data A-7.18. Vibrational levels and radiative lifetimes for $Ne_2\ {}^1\Sigma_u^+$. (The levels below the dashed line are resonant states).

		$Ne_2\ {}^1\Sigma_u^+$	
v	G[cm^{-1}]	B_v[cm^{-1}]	τ[10^{-9}s]
0	288	0.526	2.8
1	850	0.523	2.7
2	1382	0.523	2.6
3	1881	0.525	2.6
4	2348	0.525	2.5
5	2789	0.522	2.4
6	3212	0.512	2.3
7	3618	0.497	2.2
8	3999	0.479	2.0
9	4350	0.458	1.9
- - -	- - -	- - -	- - -
10	4660	0.428	1.7
11	4905	0.375	1.5
12	5044	0.217	

D_e = 4562 cm^{-1}

V_{max} = 531 cm^{-1}

R_e = 1.79×10^{-8} cm

Tabular Data A-7.19. Vibrational levels and radiative lifetimes for Ne_2 $u(^3P_2)$. (The levels below the dashed line are resonant states). The vibrational levels of the nonallowed $0_u^-(^3P_2)$ state are very similar.

	Ne_2 $^1u(^3P_2)$		
v	$G[cm^{-1}]$	$B_v[cm^{-1}]$	$\tau[10^{-6}s]$
0	285	0.523	11.9
1	843	0.520	10.2
2	1372	0.520	8.8
3	1869	0.520	7.7
4	2332	0.520	6.6
5	2767	0.517	5.6
6	3181	0.507	4.5
7	3572	0.492	3.5
8	3938	0.472	2.6
9	4267	0.446	1.8
10	4541	0.401	1.0

$D_e = 3768\ cm^{-1}$

$V_{max} = 873\ cm^{-1}$

$R_e = 1.79 \times 10^{-8} cm$

Tabular Data A-7.20. Vibrational levels and radiative lifetimes for $Ne_2\ 0_u^+(^3P_1)$ (The levels below the dashed line are resonant states).

	$Ne_2\ 0_u^+\ (^3P_1)$		
v	$G[cm^{-1}]$	$B_v[cm^{-1}]$	$\tau[10^{-9}s]$
0	285	0.523	2.8
1	843	0.520	2.7
2	1372	0.520	2.6
3	1869	0.520	2.6
4	2332	0.520	2.5
5	2767	0.517	2.4
6	3180	0.507	2.3
7	3572	0.492	2.2
8	3937	0.472	2.0
9	4266	0.446	1.9
10	4538	0.399	1.7

$D_e = 3768\ cm^{-1}$

$V_{max} = 863\ cm^{-1}$

$R_e = 1.79 \times 10^{-8}\ cm$

Tabular Data A-7-21. Calculated dipole transition matrix elements [a] for Ne_2 $^1\Sigma_u^+$ and $^1\Pi_u$ states, in length and velocity formulations, as a function of R.

$R[a_o]$	$^1\Sigma_u^+ \rightarrow {}^1\Sigma_g^+$		$^1\Pi_u \rightarrow {}^1\Sigma_g^+$	
	μ_ℓ	μ_v	μ_ℓ	μ_v
2.5	0.280	0.322	0.362	0.267
3.0	0.292	0.310	0.356	0.302
3.5	0.318	0.317	0.360	0.314
4.0	0.357	0.347	0.384	0.344
5.0	0.414	0.402	0.418	0.399
6.0	0.429	0.417	0.428	0.418
8.0	0.430	0.418	0.425	0.415
12.0	0.426	0.413	0.421	0.410

[a] In atomic units

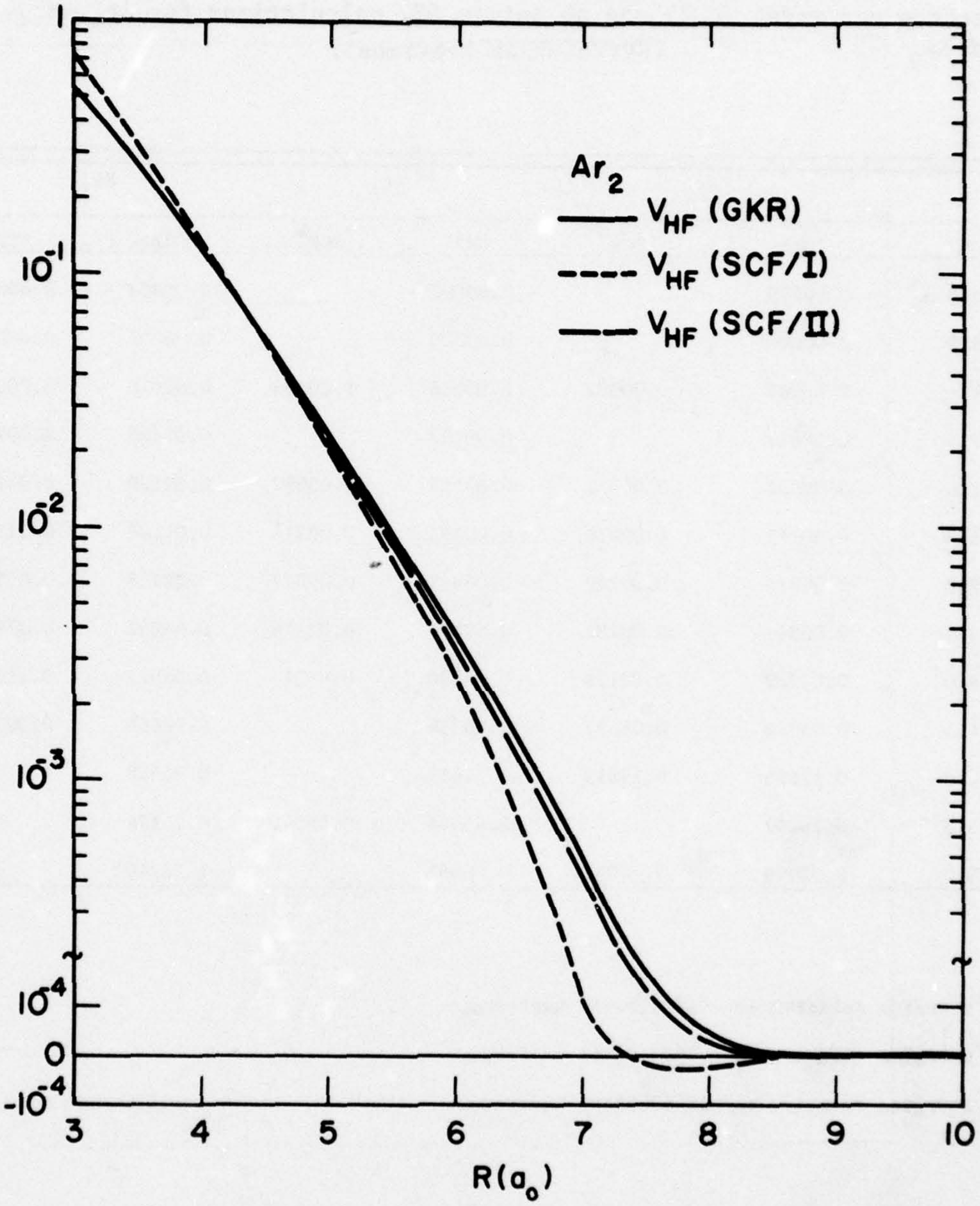
Tabular Data. A-7.22. Comparison of the HF interaction energies from the electron gas model (GKR) and ab initio SCF calculations for Ar_2, Kr_2, and Xe_2 (Energies in hartrees).

	Ar_2		Kr_2		Xe_2	
R	GKR	SCF[a]	GKR	SCF[b]	GKR	SCF[c]
10.0 a_o	0.00000		- 0.00001		- 0.00003	- 0.00002
9.0	0.00000		- 0.00000		0.00007	0.00004
8.0	0.00005	- 0.00002	0.00018	- 0.00003	0.00089	0.00098
7.5	0.00017		0.00057		0.00225	0.00270
7.0	0.00051	0.00011	0.00155	0.00092	0.00520	0.00663
6.5	0.00143	0.00070	0.00393	0.00314	0.01148	0.01524
6.0	0.00374	0.00260	0.00942	0.00877	0.02415	0.03369
5.5	0.00941	0.00782	0.02166	0.02214	0.04892	0.07218
5.0	0.02282	0.02128	0.04808	0.05315	0.09622	0.15030
4.5	0.05348	0.05497	0.10358		0.18660	0.30552
4.0	0.12065	0.13619	0.21811		0.36518	
3.5	0.26097		0.45544	0.60040	0.74174	
3.0	0.53999	0.74097	0.96468		1.57240	

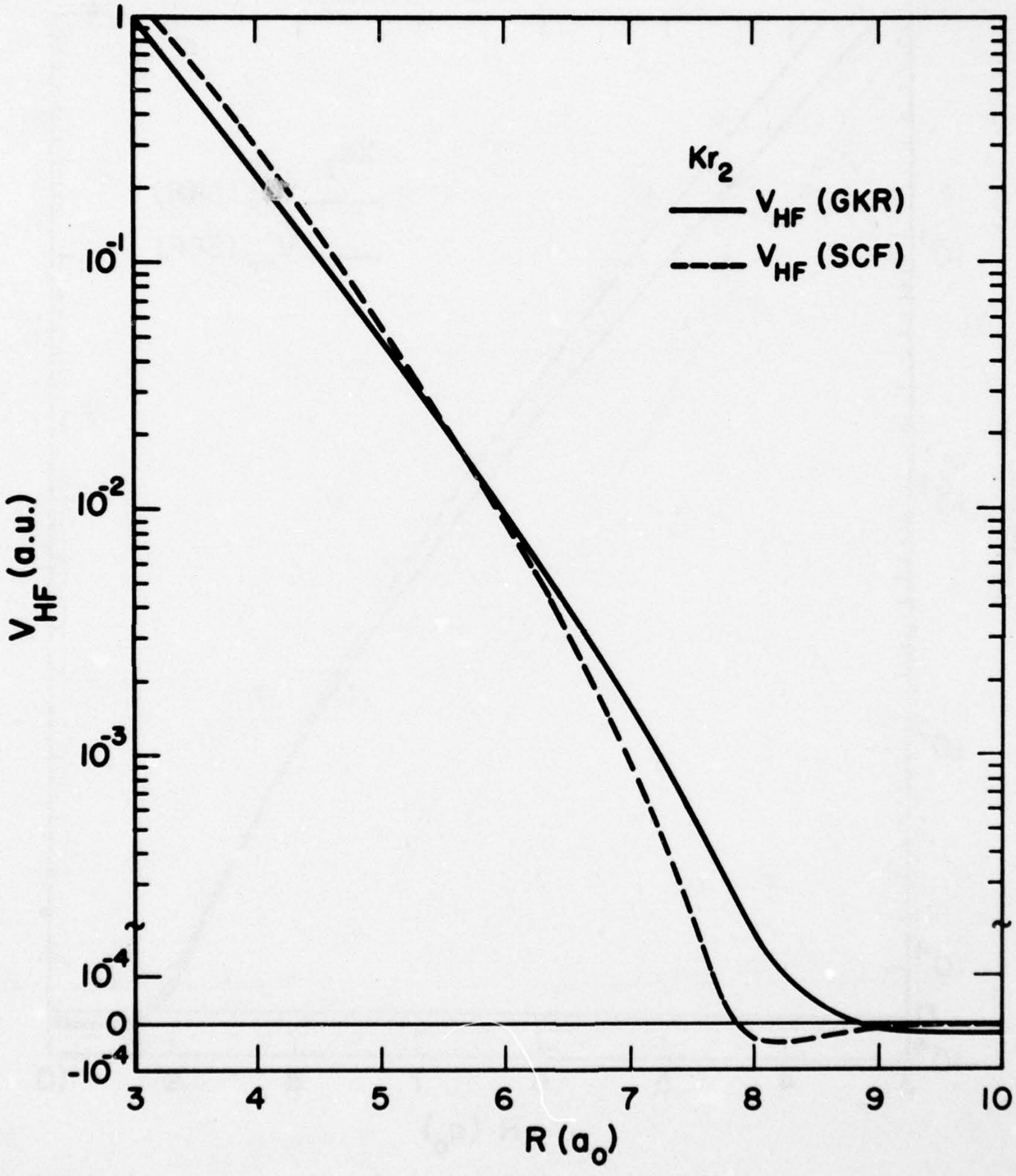
[a]Energies relative to - 1053.52988 hartrees.

[b]Energies relative to - 5503.75962 hartrees.

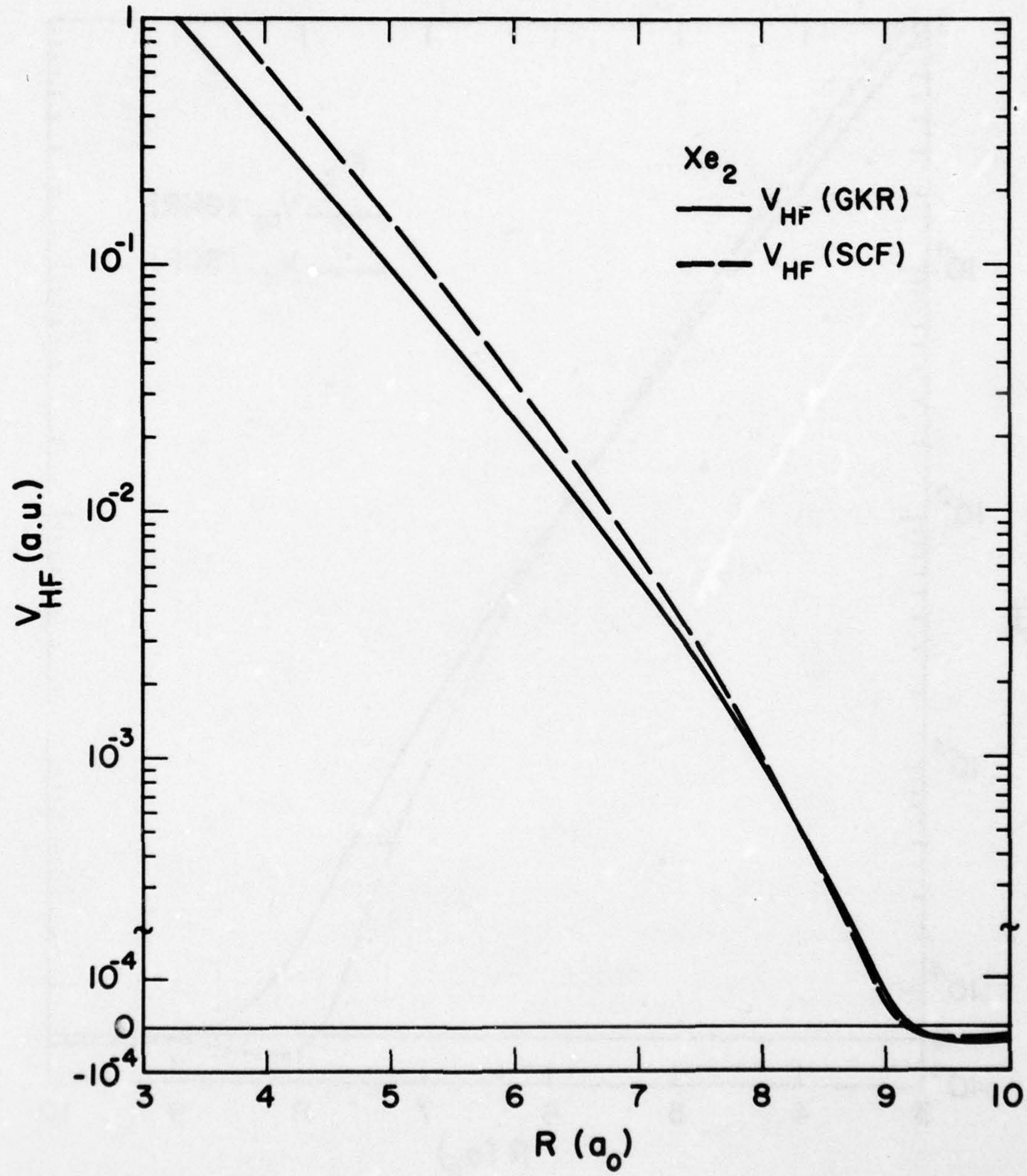
[c]Energies relative to -14463.59405 hartrees.



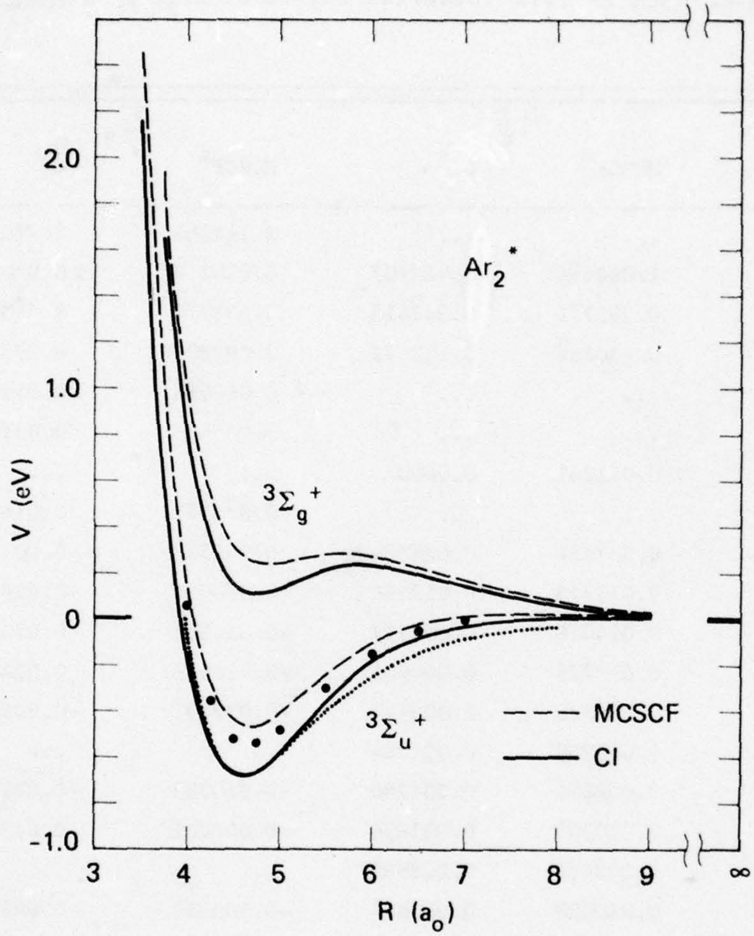
Graphical Data. A-7.23. Comparison of the Hartree-Fock (HF) interaction energy for $Ar_2(^1\Sigma^+)$ as determined by the Gordon-Kim-Rae (GKR) electron gas model and ab initio SCF calculations using basis sets I and II.



Graphical Data. A-7.24. Comparison of the HF interaction energy for Kr_2 $(^1\Sigma_g^+)$ as determined by the GKR electron gas model and ab initio SCF calculations.



Graphical Data. A-7.25. Comparison of the HF interaction energy for $Xe_2(^1\Sigma_g^+)$ as determined by the GKR electron gas model and <u>ab initio</u> SCF calculation.



Graphical Data A-7.26. Potential curves for the $^3\Sigma_g^+$ and $^3\Sigma_u^+$ states of Ar_2^*. - - - MCSCF approximation, —— CI approximation, . . . Morse functional form chosen to reproduce the spectrosopic constants of the CI curve. · are points calculated by Stevens without spin-orbit coupling. Each curve has been plotted with respect to its own asymptote.

Tabular Data A-7.27. Potential curves of Ar_2^* in atomic units.

	$^3\Sigma_g^+$		$^3\Sigma_u^+$	
$R(a_0)$	MCSCF[a]	CI[b]	MCSCF[a]	CI[c]
2.0	...	...	2.746363	2.711900
2.5	1.040676	0.985107	0.970236	0.950265
3.0	0.385776	0.345613	0.338772	0.320080
3.5	0.130266	0.112572	0.092801	0.077563
3.6	...	...	0.066686	0.052162
3.7	...	...	0.045655	0.031956
3.75	0.071201	0.060077	...	...
3.8	...	...	0.028902	0.016125
4.0	0.037454	0.028884	0.005550	-0.005763
4.25	0.019713	0.012596	-0.010055	-0.019757
4.4	0.014018	0.007517	-0.014580	-0.023405
4.55	0.010775	0.004905	-0.016693	-0.024813
4.7	0.009210	0.003947	-0.017131	-0.024535
4.85	0.008730	0.004044	...	...
5.0	0.008879	0.004780	-0.015083	-0.021215
5.5	0.010303	0.007896	-0.008901	-0.013261
5.75	0.010432	0.008639	...	...
6.0	0.010028	0.008644	-0.003757	-0.006778
6.25	0.009250	0.008118	...	...
6.5	0.008276	0.007297	-0.000740	-0.002819
7.0	0.006234	0.005430	0.000662	-0.000796
8.0	0.003074	0.002491	0.001132	0.000344
9.0	0.001334	0.000918	0.000709	0.000234
10.0	0.000499	0.000207	...	...
12.0	-0.000010	-0.000147	-0.000027	-0.000164
∞	0.0	0.0	0.0	0.0

[a]Asymptotic energy =-1053.208106.

[b]Asymptotic energy =-1053.23082921.

[c]Asymptotic energy =-1053.23082620.

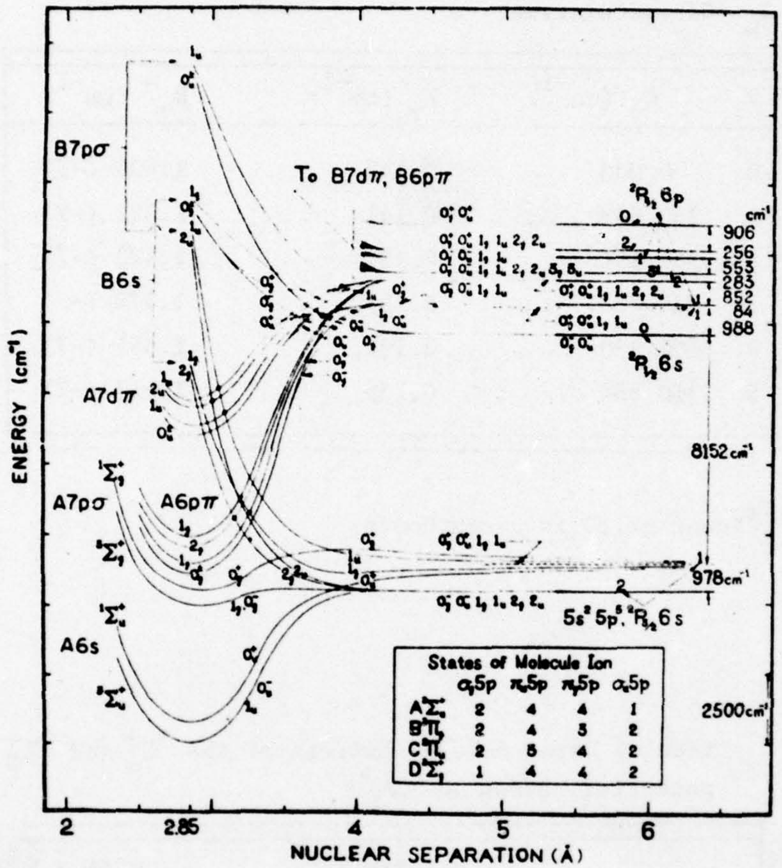
Tabular Data. A-7.28. Spectroscopic constants of Ar_2^* for the $^3\Sigma_u^+$ CI calculation.

V	G_v (cm^{-1})	B_v (cm^{-1})	D_v[a] (cm^{-1})
0	0.000	0.142	1.406 (-7)
1	283.848	0.141	1.422 (-7)
2	563.150	0.139	1.492 (-7)
3	835.733	0.138	1.573 (-7)
4	1100.930	0.136	1.555 (-7)
5	1360.854	0.135	1.517 (-7)

[a]Power of 10 in parentheses.

Tabular Data. A-7.29. Extrema of the $^3\Sigma_u^+$ and $^3\Sigma_g^+$ potential curves of Ar_2^*.

	$R(a_o)$	V (a.u.)
$^3\Sigma_u^+$ minimum		
MCSCF	4.67	-0.01715
CI	4.59	-0.02488
$^3\Sigma_g^+$ minimum		
MCSCF	4.88	0.00872
CI	4.76	0.00389
$^3\Sigma_g^+$ maximum		
MCSCF	5.68	0.01045
CI	5.87	0.00872



Graphical Data. A-7.30. Estimated potential curves for some of the lower excited states (Rydberg states) of Xe_2.

Tabular Data. A-7.31.

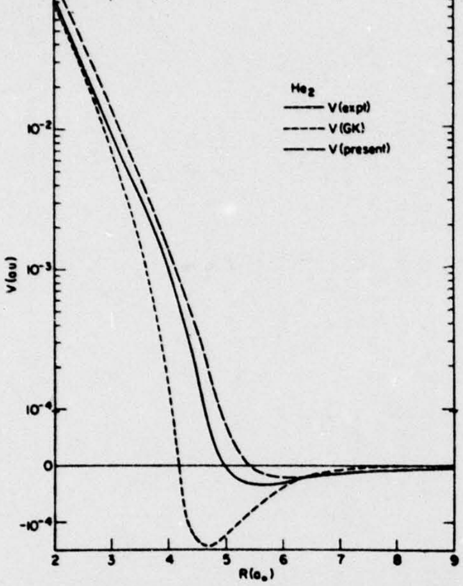
Calculated interatomic potential curves for the noble gas pairs. At the bottom the calculated properties are compared to the results obtained in recent low-energy crossed molecular beam experiments (in parentheses).

$R(a_0)$	$V(R)$ (a.u.)						
	He–He	He–Ne	He–Ar	He–Kr	He–Xe	Ne–Ne	Ne–Ar
0.5	0.3476E+1	0.1331E+2	0.2023E+2	0.3300E+2	0.4698E+2	0.5532E+2	0.8651E+2
1.0	0.9189	0.2947E+1	0.4328E+1	0.6595E+1	0.8579E+1	0.1075E+2	0.1630E+2
1.5	0.3271	0.9699	0.1402E+1	0.1966E+1	0.2554E+1	0.3258E+1	0.4665E+1
2.0	0.1195	0.3354	0.5720	0.7341	0.9294	0.1070E+1	0.1776E+1
2.5	0.4257E−1	0.1132	0.2451	0.3124	0.4002	0.3438	0.7411
3.0	0.1447E−1	0.3637E−1	0.1006	0.1336	0.1827	0.1054	0.2964
3.5	0.4684E−2	0.1114E−1	0.3957E−1	0.5626E−1	0.8460E−1	0.3123E−1	0.1147
4.0	0.1402E−2	0.3123E−2	0.1453E−1	0.2230E−1	0.3728E−1	0.8611E−2	0.4167E−1
4.5	0.3686E−3	0.7384E−3	0.4895E−2	0.8214E−2	0.1545E−1	0.2071E−2	0.1414E−1
5.0	0.7190E−4	0.1016E−3	0.1429E−2	0.2711E−2	0.5915E−2	0.3334E−3	0.4328E−2
5.5	−0.5628E−5	−0.4120E−4	0.2925E−3	0.7189E−3	0.2006E−2	−0.6320E−4	0.1070E−2
6.0	−0.2020E−4	−0.5726E−4	−0.2603E−4	0.7842E−4	0.5263E−3	−0.1188E−3	0.1012E−3
6.5	−0.1822E−4	−0.4523E−4	−0.9375E−4	−0.8952E−4	0.3343E−4	−0.9733E−4	−0.1427E−3
7.0	−0.1345E−4	−0.3142E−4	−0.8836E−4	−0.1117E−3	−0.1022E−3	−0.6819E−4	−0.1664E−3
7.5	−0.9365E−5	−0.2108E−4	−0.6741E−4	−0.9282E−4	−0.1170E−3	−0.4580E−4	−0.1345E−3
8.0	−0.6438E−5	−0.1415E−4	−0.4798E−4	−0.6851E−4	−0.9745E−4	−0.3070E−4	−0.9805E−4
8.5	−0.4456E−5	−0.9636E−5	−0.3344E−4	−0.4845E−4	−0.7299E−4	−0.2086E−4	−0.6912E−4
9.0	−0.3128E−5	−0.6694E−5	−0.2334E−4	−0.3390E−4	−0.5250E−4	−0.1447E−4	−0.4850E−4
9.5	−0.2234E−5	−0.4748E−5	−0.1647E−4	−0.2384E−4	−0.3732E−4	−0.1024E−4	−0.3432E−4
10.0	−0.1623E−5	−0.3435E−5	−0.1181E−4	−0.1699E−4	−0.2661E−4	−0.7401E−5	−0.2464E−4
10.5	−0.1199E−5	−0.2529E−5	−0.8621E−5	−0.1232E−4	−0.1919E−4	−0.5445E−5	−0.1799E−4
11.0	−0.8988E−6	−0.1893E−5	−0.6399E−5	−0.9084E−5	−0.1407E−4	−0.4071E−5	−0.1335E−4
11.5	−0.6831E−6	−0.1437E−5	−0.4824E−5	−0.6813E−5	−0.1049E−4	−0.3089E−5	−0.1006E−4
12.0	−0.5256E−6	−0.1105E−5	−0.3689E−5	−0.5189E−5	−0.7943E−5	−0.2374E−5	−0.7693E−5
$R_m(a_0)$	6.10	5.90	6.64	6.91	7.37	5.98	6.84
	(5.60)[a]	(6.07)[b]	(6.69)[b]	(7.09)[b]	(7.84)[b]	(5.88)[a]	(6.48)[c]
ϵ(a.u.)	0.204E−4	0.579E−4	0.960E−4	0.112E−3	0.118E−3	0.119E−3	0.169E−3
	(0.349E−4)[a]	(0.453E−4)[b]	(0.766E−4)[b]	(0.782E−4)[b]	(0.798E−4)[b]	(0.135E−3)[a]	(0.228E−3)[c]
$\sigma(a_0)$	5.43	5.26	5.92	6.15	6.57	5.35	6.13
	(4.97)[a]	(5.16)[b]	(5.84)[b]	(6.17)[b]	(6.82)[b]	(5.23)[a]	(5.84)[c]

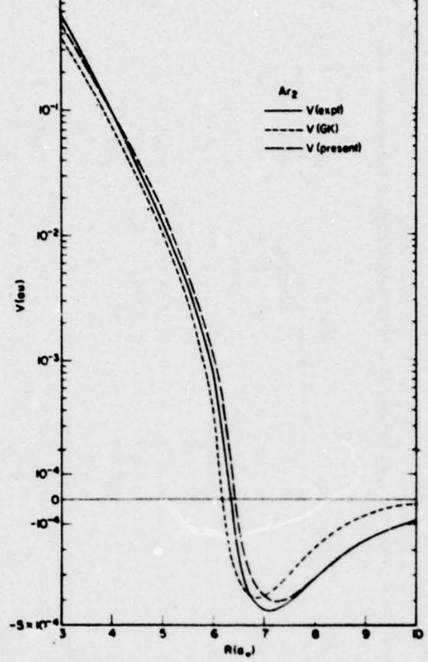
[c]C. Y. Ng, Y. T. Lee, and J. A. Barker, preprint 1974.
[d]J. M. Parson, T. P. Schafer, P. E. Siska, F. P. Tully, Y. C. Wong, and Y. T. Lee, J. Chem. Phys. 53, 3755 (1970).

Tabular Data. A-7.32.

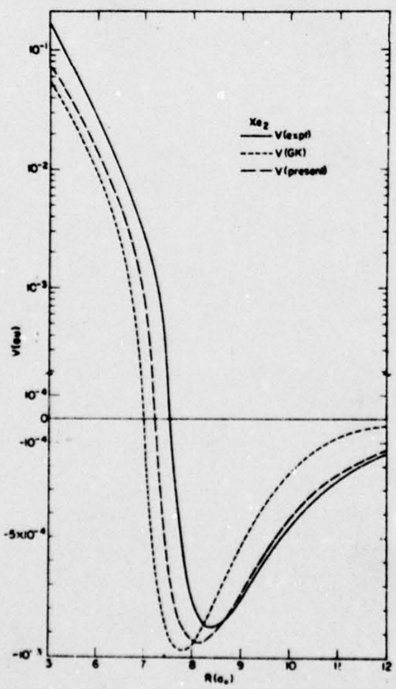
V(R)(a.u.)							
Ne–Kr	Ne–Xe	Ar–Ar	Ar–Kr	Ar–Xe	Kr–Kr	Kr–Xe	Xe–Xe
0.1484E+3	0.2058E+3	0.1437E+3	0.2464E+3	0.3435E+3	0.4379E+3	0.6072E+3	0.8451E+3
0.2583E+2	0.3428E+2	0.2647E+2	0.4042E+2	0.5714E+2	0.6562E+2	0.9096E+2	0.1266E+3
0.6975E+1	0.9241E+1	0.7884E+1	0.1167E+2	0.1523E+2	0.1684E+2	0.2310E+2	0.3179E+2
0.2356E+1	0.3074E+1	0.2648E+1	0.4014E+1	0.5199E+1	0.5859E+1	0.7559E+1	0.1008E+2
0.9567	0.1238E+1	0.1082E+1	0.1528E+1	0.1974E+1	0.2237E+1	0.2917E+1	0.3766E+1
0.3991	0.5457	0.4875	0.6402	0.8010	0.8914	0.1154E+1	0.1461E+1
0.1664	0.2508	0.2279	0.2989	0.3809	0.4072	0.5300	0.6632
0.6577E−1	0.1102	0.1003	0.1361	0.1836	0.1867	0.2500	0.3127
0.2453E−1	0.4603E−1	0.4109E−1	0.5888E−1	0.8618E−1	0.8341E−1	0.1179	0.1509
0.8481E−2	0.1811E−1	0.1538E−1	0.2365E−1	0.3818E−1	0.3527E−1	0.5372E−1	0.7221E−1
0.2585E−2	0.6592E−2	0.4976E−2	0.8468E−2	0.1549E−1	0.1362E−1	0.2287E−1	0.3292E−1
0.5826E−3	0.2105E−2	0.1128E−2	0.2391E−2	0.5403E−2	0.4415E−2	0.8617E−2	0.1360E−1
−0.2266E−4	0.4930E−3	−0.9633E−4	0.2236E−3	0.1291E−2	0.8443E−3	0.2470E−2	0.4590E−2
−0.1676E−3	−0.3379E−4	−0.3900E−3	−0.3950E−3	−0.1622E−3	−0.3300E−3	0.1019E−3	0.7428E−3
−0.1664E−3	−0.1653E−3	−0.3915E−3	−0.4900E−3	−0.5389E−3	−0.5894E−3	−0.6023E−3	−0.6042E−3
−0.1313E−3	−0.1682E−3	−0.3153E−3	−0.4251E−3	−0.5604E−3	−0.5622E−3	−0.7184E−3	−0.9284E−3
−0.9598E−4	−0.1364E−3	−0.2344E−3	−0.3278E−3	−0.4687E−3	−0.4535E−3	−0.6349E−3	−0.8913E−3
−0.6839E−4	−0.1022E−3	−0.1690E−3	−0.2409E−3	−0.3599E−3	−0.3416E−3	−0.5025E−3	−0.7392E−3
−0.4862E−4	−0.7441E−4	−0.1210E−3	−0.1739E−3	−0.2663E−3	−0.2500E−3	−0.3784E−3	−0.5732E−3
−0.3487E−4	−0.5380E−4	−0.8703E−4	−0.1254E−3	−0.1943E−3	−0.1813E−3	−0.2787E−3	−0.4297E−3
−0.2536E−4	−0.3916E−4	−0.6331E−4	−0.9112E−4	−0.1418E−3	−0.1319E−3	−0.2042E−3	−0.3181E−3
−0.1875E−4	−0.2891E−4	−0.4670E−4	−0.6702E−4	−0.1043E−3	−0.9689E−4	−0.1504E−3	−0.2355E−3
−0.1408E−4	−0.2164E−4	−0.3497E−4	−0.5000E−4	−0.7765E−4	−0.7208E−4	−0.1118E−3	−0.1753E−3
−0.1073E−4	−0.1643E−4	−0.2656E−4	−0.3784E−4	−0.5856E−4	−0.5436E−4	−0.8409E−4	−0.1317E−3
7.22 (6.77)[c]	7.74 (7.09)[c]	7.23 (7.11)[a]	7.45 (7.18)[d]	7.78 (7.75)[d]	7.66 (7.77)[a]	7.94	8.14 (8.41)[a]
0.175E−3 (0.236E−3)[c]	0.175E−3 (0.236E−3)[c]	0.409E−3 (0.446E−3)[a]	0.491E−3 (0.546E−3)[d]	0.574E−3 (0.601E−3)[d]	0.599E−3 (0.629E−3)[a]	0.721E−3	0.941E−3 (0.874E−3)[a]
6.47 (6.09)[c]	6.95 (6.46)[c]	6.43 (6.32)[a]	6.61	6.91	6.79 (6.87)[a]	7.05	7.21 (7.53)[a]



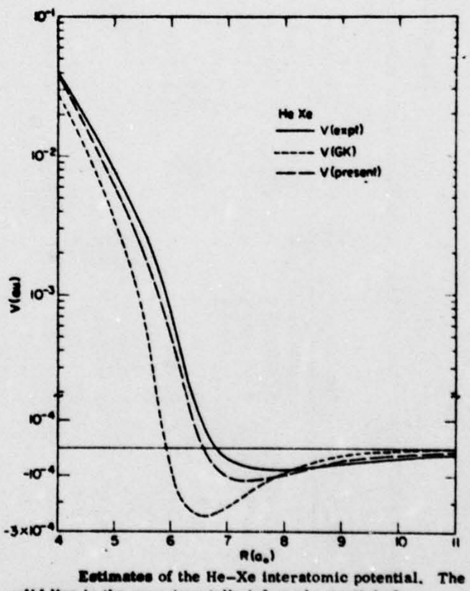
Estimates of the He$_2$ interatomic potential energy. The solid line is the experimentally inferred potential of Ref. A-7.30, the short-dashed line the unmodified GK potential, and the long-dashed line the present result. Hartree atomic units are used.



Estimates of the Ar$_2$ interatomic potential energy.



Estimates of the Xe$_2$ interatomic potential energy.



Estimates of the He–Xe interatomic potential. The solid line is the experimentally inferred potential of A-7.31.

Graphical Data. A-7.33.

A-8. RADIATIVE LIFETIMES OF THE RARE-GAS ATOMS

CONTENTS

A-8 Reference

Radiative Lifetimes of the Rare-Gas Atoms

Tabulations and references for transition probabilities of the rare-gas atoms can be found in the following six important references, and are therefore not reproduced here.

1. W. L. Wiese, M. W. Smith and B. M. Glennon, "Atomic transition probabilities. Volume 1. Hydrogen through neon," Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 4, 157 pages (May 1966).

2. W. L. Wiese, M. W. Smith and B. M. Miles, "Atomic transition probabilities. Volume 2. Sodium through calcium," Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 22, 306 pages (Oct 1969).

3. B. M. Miles and W. L. Wiese, "Bibliography on atomic transition probabilities (January 1916 through June 1971), Nat. Bur. Stand. (U.S.), Spec. Publ. 320, (Feb. 1970).

4. J. R. Fuhr and W. L. Wiese, "Bibliography on atomic transition probabilities (July 1969 through June 1971), Nat. Bur. Stand. (U.S.), Spec. Publ. 320, Suppl. 1 (Sept. 1971).

5. J. R. Fuhr and W. L. Wiese, "Bibliography on atomic transition probabilities (July 1971 through June 1973), Nat. Bur. Stand. (U.S.), Spec. Publ. 320, Suppl. 2 (Nov. 1973).

6. B. J. Millar, J. R. Fuhr and G. A. Martin, "Bibliography on atomic transition probabilities (July 1973 through June 1977), (to be published 1978).

The tables of lifetimes in (A-8.1)-(A-8.12) are taken from the following more recent sources.

(A-8.1)-(A-8.4):

H. H. Bukow, G. Heine and M. Reinke, "Lifetime measurements on atomic states of HeI," J. Phys. B: Atom. Molec. Phys. 10, 2347 (1977).

(A-8.5)-(A-8.6):

P. F. Gruzdev and A. V. Loginov, "Neon, radiative lifetimes for the levels of the $2p^5ms$, $2p^5np$, $2p^5nd$ (m=3-6, n=3-5) and $2p^54f$ configurations," Opt. Spectrosc. 35, 1 (1973).

N. V. Afanaseva and P. F. Gruzdev, "Lifetimes of ns and np levels of a neon atom," Opt. Spectrosc. 38, 211 (1975).

N. V. Afanaseva and P. F. Gruzdev, "Lifetimes of nd and nf levels of the neon atom," Opt. Spectrosc. 38, 583 (1975).

(A-8.7):

A. V. Loginov and P. F. Gruzdev, "Neon transition probabilities. 1. Transitions $2p^53p-2p^5ns$ (n=3-6)," Opt. Spectrosc. 37, 467 (1974).

P. F. Gruzdev and A. V. Loginov, "Neon transition probabilities. Part 2: $2p^54p-2p^5ns$ (n=3-6) transitions," Opt. Spectrosc. 39, 464 (1975).

(A-8.8)-(A-8.9):

P. F. Gruzdev and A. V. Loginov, "Radiation lifetimes of the argon atom," Opt. Spectrosc. 38, 234 (1975).

N. V. Afanaseva and P. F. Gruzdev, "Lifetimes of the ns and np levels of the argon atom," Opt. Spectrosc. 38, 450 (1975).

(A-8.10):

P. F. Gruzdev and A. V. Loginov, "Radiation lifetimes of levels of the KrI atom," Opt. Spectrosc. 38, 611 (1975).

(A-8.11):

A. V. Loginov and P. F. Gruzdev, "Radiation lifetimes of xenon levels," Opt. Spectrosc. 41, 104 (1976).

(A-8.13):

V. P. Samilov, Yu. M. Smirnov and G. S. Starikova, "Transition probabilities and cross sections for excitation of Xe II," Opt. Spectrosc. 38, 707 (1975).

Tabular Data A-8.1.

Lifetimes of He states (n = 3, 4 and 5). The wavelength of the observed transition is given in the first column. Theoretical lifetimes are calculated from the work of Wiese *et al* (1966). The table is divided into two parts, (*a*) singlet states and (*b*) triplet states. A list of references for the sources quoted is given after the table.

(*a*) Singlet states.

Wave-length (nm)	State	Lifetime (ns) Theory	$\delta\tau$ (%)	This work	$\delta\tau$ (%)	Other authors	$\delta\tau$ (%)	Source
728·1	3^1S	55·2 ± 1·7	3	50·3 ± 2·3	4·6	54·1 ± 0·6	1·1	KB 63
						55 ± 6	11	BKM 65
						60 ± 3	5	OV 68
						55·9 ± 2	3·6	TF 75
504·7	4^1S	89·8 ± 4·0	4·5	77·9 ± 3·5	4·5	87 ± 1·5	1·7	KB 63
						84 ± 9	11	BKM 65
						97 ± 2	2·1	PH 65
						83 ± 5	6·0	BK 67
						75 ± 4	5·3	OV 68
						89 ± 3	3·4	JF 70
						87 ± 1·5	1·7	CBHG 70
						75 ± 1	1·3	IR 71
						88 ± 1	1·1	KOSB 73
						89 ± 3	3·4	TF 75
443·7	5^1S	150 ± 12	8·2	109 ± 16	15	133 ± 18	13	KB 63
						141		BKM 65
						144 ± 3	2·1	PH 65
						115 ± 5	4·3	OV 68
						118 ± 8	6·8	AJS 69
						145 ± 6	4·1	KOSB 73
						160 ± 3	1·9	TF 75
501·5	3^1P	1·725 ± 0·017	1·0	1·70 ± 0·04	2·3	⩽ 15		BD 59
						72 ± 1	1·4	PH 65
						66 ± 7	11	BK 67
						9 ± 1	11	OV 68
						60 ± 20	33	AJS 69
						1·78 ± 0·10	5·6	MB 69
						1·73 ± 0·11	6·3	BL 71
						1·80 ± 0·1	5·6	CDDG 71
						1·72 ± 0·1	5·8	KKC 75
						1·74 ± 0·02	1·15	ACLMS 76
						1·7225 ± 0·0046	0·27	ACLMM 76

Tabular Data A-8.2.

Lifetime measurements of He I

(*a*) Singlet states (continued).

Wave-length (nm)	State	Lifetime (ns) Theory	$\delta\tau$ (%)	This work	$\delta\tau$ (%)	Other authors	$\delta\tau$ (%)	Source
396·4	4^1P	3·92 ± 0·11	2·9	4·05 ± 0·12	3·0	11 ± 1	9·1	FNPP 63
						3·7 ± 0·4	10·8	MB 69
						4·02 ± 0·1	2·5	ACLMS 76
667·8	3^1D	15·67 ± 0·47	3·0	15·2 ± 0·5	3·3	16·5 ± 2	12	DPPB 60
						16·5 ± 1	6·1	FNPP 63
						16 ± 4	25	KB 63
						18 ± 5	28	FHJC 64
						16 ± 2	12	PH 65
						16 ± 1	6·2	OV 68
						12 ± 3	25	D 69
						20·5 ± 0·9	4·4	DW 69
						15·5 ± 5	32	AJS 69
						13·4 ± 0·5	3·7	IR 71
						20·3 ± 3	15	CBD 72
						15·8 ± 0·1	0·63	B 72
						17 ± 2	12	KKC 73
						20 ± 1	5	TF 75
492·1	4^1D	36·6 ± 1·2	3·4	32·9 ± 2·3	7	39·1 ± 2	5·1	DPPB 60
						30 ± 5	17	KB 63
						38 ± 1	2·6	FNPP 63
						35 ± 4	11	FHJC 64
						47 ± 5	11	PH 65
						39 ± 5	13	BK 67
						30 ± 2	6·7	OV 68
						41 ± 5	12	D 69
						38 ± 2	5·3	DW 69
						38 ± 5	13	AJS 69
						34 ± 1	2·9	CBHG 70
						38 ± 3	7·9	MBBBLBB 70
						41 ± 3	7·3	JF 70
						33·6 ± 3	8·9	CBD 72
						39·2 ± 0·8	2	B 72
						38·4 ± 2·1	5·5	BJ 73
						33 ± 7	21	KKC 73
						41 ± 3	7·3	TF 75
438·7	5^1D	≤ 72·0 ± 2·3	3·3	63·5 ± 5·7	9·0	49·1 ± 2	4·1	DPPB 60
						46 ± 3	6·5	KB 63
						79 ± 6	7·6	PH 65
						63 ± 9	14	BK 67
						49 ± 5	10	OV 68
						49 ± 5	10	D 69
						68·0 ± 7	10	DW 69
						46 ± 3	6·5	AJS 69
						66 ± 4	6·1	MBBBLBB 70
						71·9 ± 1·8	2·5	B 72
						74·4 ± 5	6·7	CBD 72
						80 ± 40	50	KKC 73
						52 ± 6	11	YHM 73
						56 ± 10	18	TF 75
	4^1F	72·5 ± 7·2	10	80 ± 6	7·5	—		

Tabular Data A-8.3. Triplet states of He.

Wave-length (nm)	State	Lifetime (ns) Theory	$\delta\tau$ (%)	This work	$\delta\tau$ (%)	Other authors	$\delta\tau$ (%)	Source
706·5	3^3S	36·0 ± 1·1	3	35·1 ± 1·3	3·7	40·8 ± 0·8	2	KB 63
						47 ± 3	6·4	OV 68
						57 ± 1	1·8	TF 75
471·3	4^3S	58·4 ± 4·2	7·3	62·0 ± 2·7	4·4	67·5 ± 1	1·5	HWR 56
						77·5 ± 4	5·2	BD 59
						59 ± 6	10	FHJC 64
						64·5 ± 4	6·2	BKM 65
						68 ± 1	1·5	PH 65
						65 ± 4	6·2	BK 67
						69 ± 3	4·3	OV 68
						63·5 ± 1·2	1·9	IR 71
						59·2 ± 0·6	1	KOSB 73
						62 ± 3	4·8	TF 75
412·1	5^3S	111·0 ± 6·7	6·1	100 ± 15	15	113 ± 4	3·5	PH 65
						99 ± 6	6·1	BK 67
						106 ± 5	4·6	OV 68
						111 ± 1	0·9	KOSB 73
						120 ± 20	17	TF 75
388·9	3^3P	94·71 ± 0·90	0·95	89 ± 5	5·6	115 ± 5	4·3	HWR 56
						106 ± 5	4·7	BD 59
						95·8 ± 60	63	DPPB 60
						91 ± 8	8·8	FHJC 64
						115 ± 2	1·7	PH 65
						100 ± 3	3	BK 67
						115 ± 5	4·3	OV 68
						89 ± 5	5·6	D 69
						93 ± 12	13	MBBBLBB 70
						122 ± 5	4·3	JF 70
						111 ± 5	4·5	CBHG 70
						98 ± 4·3	4·4	B 72
						89 ± 10	11	S 72
						122 ± 5	4·1	TF 75
587·6	3^3D	14·16 ± 0·42	3	14·25 ± 0·34	2·4	10 ± 5	50	HWR 56
						25 ± 5	20	FHJC 64
						13 ± 3	23	DGJ 65
						15 ± 2	13	PH 65
						13 ± 2	15	OV 68
						17 ± 3	18	D 69
						13·3 ± 1·5	11	MBBBLBB 70
						14 ± 3	2	CBHG 70
						13·4 ± 0·5	3·7	IR 71
						19·4 ± 0·5	2·6	TF 75
447·1	4^3D	31·5 ± 1·0	3·2	32·1 ± 1·3	4	29 ± 3	10	DGJ 65
						37 ± 6	16	PH 65
						23 ± 2	8·7	OV 68
						42 ± 4	9·5	D 69
						27 ± 3	11	MBBBLBB 70
						32 ± 1	3·1	CBHG 70
						35·5 ± 1·2	3·4	B 72
						28 ± 10	36	TF 75
402·6	5^3D	≤60·9 ± 1·9	3	57·2 ± 2·3	4	42 ± 5	12	DGJ 65
						35 ± 3	8·6	OV 68
						59 ± 8	14	D 69
						55 ± 5	6·1	MBBBLBB 70
						132		TF 75
	4^3F	71·9 ± 7·2	10	71·6 ± 3	4·2			

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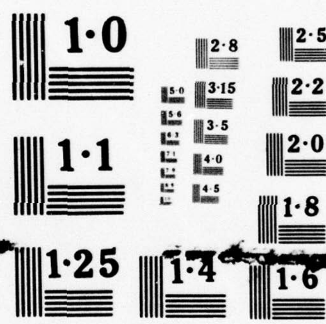

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Tabular Data A-8.4.

Lifetime measurements of He I

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Tabular Data A-8.5.

Lifetimes (in nsec) for levels of the configurations $2p^5$ nd (n = 6–9) and $2p^5$ nf (n = 5–8) of the neon atom calculated in Jl coupling

Level	τ_{Jl}	Level	τ_{Jl}	Level	τ_{Jl}
$6d\,[1/2]^{\circ}_{0}$	201	$5f'\,[7/2]_{3}$	140	$9d\,[3/2]^{\circ}_{2}$	787
$6d\,[1/2]^{\circ}_{1}$	71.6	$5f'\,[7/2]_{4}$	140	$9d\,[3/2]^{\circ}_{1}$	256
$6d\,[7/2]^{\circ}_{4}$	224	$5f'\,[5/2]_{3}$	142	$9d\,[5/2]^{\circ}_{2}$	835
$6d\,[7/2]^{\circ}_{3}$	230	$5f'\,[5/2]_{2}$	142	$9d\,[5/2]^{\circ}_{3}$	837
$6d\,[3/2]^{\circ}_{2}$	218	$6f\,[3/2]_{1}$	235	$9d'\,[5/2]^{\circ}_{2}$	819
$6d\,[3/2]^{\circ}_{1}$	73.5	$6f\,[3/2]_{2}$	235	$9d'\,[5/2]^{\circ}_{3}$	830
$6d\,[5/2]^{\circ}_{2}$	235	$6f\,[9/2]_{4}$	237	$9d'\,[3/2]^{\circ}_{2}$	863
$6d\,[5/2]^{\circ}_{3}$	236	$6f\,[9/2]_{5}$	237	$9d'\,[3/2]^{\circ}_{1}$	255
$6d'\,[5/2]^{\circ}_{2}$	230	$6f\,[5/2]_{2}$	242	$7f\,[3/2]_{1}$	371
$6d'\,[5/2]^{\circ}_{3}$	234	$6f\,[5/2]_{3}$	241	$7f\,[3/2]_{2}$	371
$6d'\,[3/2]^{\circ}_{2}$	238	$6f\,[7/2]_{3}$	244	$7f\,[9/2]_{4}$	374
$6d'\,[3/2]^{\circ}_{1}$	74.4	$6f\,[7/2]_{4}$	245	$7f\,[9/2]_{5}$	374
$7d\,[1/2]^{\circ}_{0}$	330	$6f'\,[7/2]_{3}$	240	$7f\,[5/2]_{2}$	382
$7d\,[1/2]^{\circ}_{1}$	108	$6f'\,[7/2]_{4}$	240	$7f\,[5/2]_{3}$	379
$7d\,[7/2]^{\circ}_{4}$	362	$6f'\,[5/2]_{2}$	242	$7f\,[7/2]_{3}$	384
$7d\,[7/2]^{\circ}_{3}$	371	$6f'\,[5/2]_{3}$	242	$7f\,[7/2]_{4}$	395
$7d\,[3/2]^{\circ}_{2}$	355	$8d\,[1/2]^{\circ}_{0}$	509	$7f'\,[7/2]_{3}$	378
$7d\,[3/2]^{\circ}_{1}$	110	$8d\,[1/2]^{\circ}_{1}$	170	$7f'\,[7/2]_{4}$	378
$7d\,[5/2]^{\circ}_{2}$	380	$8d\,[7/2]^{\circ}_{4}$	559	$7f'\,[5/2]_{2}$	381
$7d\,[5/2]^{\circ}_{3}$	381	$8d\,[7/2]^{\circ}_{3}$	571	$7f'\,[5/2]_{3}$	381
$7d'\,[5/2]^{\circ}_{2}$	373	$8d\,[3/2]^{\circ}_{2}$	548	$8f\,[3/2]_{1}$	551
$7d'\,[5/2]^{\circ}_{3}$	378	$8d\,[3/2]^{\circ}_{1}$	174	$8f\,[3/2]_{2}$	551
$7d'\,[3/2]^{\circ}_{2}$	389	$8d\,[5/2]^{\circ}_{2}$	583	$8f\,[9/2]_{4}$	556
$7d'\,[3/2]^{\circ}_{1}$	111	$8d\,[5/2]^{\circ}_{3}$	585	$8f\,[9/2]_{5}$	556
$5f\,[3/2]_{1}$	137	$8d'\,[5/2]^{\circ}_{2}$	573	$8f\,[5/2]_{2}$	566
$5f\,[3/2]_{2}$	137	$8d'\,[5/2]^{\circ}_{3}$	580	$8f\,[5/2]_{3}$	562
$5f\,[9/2]_{4}$	139	$8d'\,[3/2]^{\circ}_{2}$	598	$8f\,[7/2]_{3}$	569
$5f\,[9/2]_{5}$	139	$8d'\,[3/2]^{\circ}_{1}$	174	$8f\,[7/2]_{4}$	569
$5f\,[5/2]_{2}$	142	$9d\,[1/2]^{\circ}_{0}$	735	$8f'\,[7/2]_{3}$	561
$5f\,[5/2]_{3}$	141	$9d\,[1/2]^{\circ}_{1}$	251	$8f'\,[7/2]_{4}$	561
$5f\,[7/2]_{3}$	143	$9d\,[7/2]^{\circ}_{4}$	802	$8f'\,[5/2]_{2}$	564
$5f\,[7/2]_{4}$	143	$9d\,[7/2]^{\circ}_{3}$	818	$8f'\,[5/2]_{3}$	565

Radiative lifetimes (in nsec) of atomic neon levels

Levels according to Paschen	τ_{OA}		τ_{MA}	Levels according to Paschen	τ_{OA}		τ_{MA}
	τ_1	τ_2			τ_1	τ_2	
1	2	3	4	1	2	3	4
$1s_5$	24.4	23.5	23.5	$4d_3$	35.7	35.8	35.5
$1s_2$	1.80	1.73	1.76	$4d_2$	18.0	17.1	17.7
$2p_{10}$	26.2	22.9	22.3	$4d_1''$	68.3	68.2	67.7
$2p_9$	19.7	17.2	17.3	$4d_1'$	51.5	51.5	51.8
$2p_8$	21.2	18.6	18.3	$4s_1''''$	50.5	50.5	50.3
$2p_7$	20.5	17.9	17.9	$4s_1'''$	46.1	46.1	45.9
$2p_6$	20.9	18.2	17.6	$4s_1''$	76.1	76.1	76.1
$2p_3$	16.4	14.3	13.9	$4s_1'$	22.5	21.6	22.4
$2p_5$	18.8	16.4	16.9	$4X_1$	77.7	74.7	75.6
$2p_4$	17.7	15.5	15.4	$4X_2$	68.7	66.0	65.8
$2p_2$	16.3	14.3	14.5	$4V_4$	73.4	70.5	69.1
$2p_1$	14.8	12.9	11.9	$4V_5$	70.4	67.7	68.6
$2s_5$	39.4	36.1	37.4	$4Y_2$	72.0	69.2	70.2
$2s_4$	11.0	10.7	10.0	$4Y_3$	71.8	69.0	69.3
$2s_3$	47.2	43.2	44.0	$4Z_3$	69.0	66.3	66.5
$2s_2$	8.68	8.43	7.84	$4Z_4$	70.5	67.8	133
$3d_6$	17.0	15.4	16.3	$4W_3$	70.2	67.5	67.6
$3d_5$	14.9	13.9	15.1	$4W_4$	71.5	68.7	68.7
$3d_4'$	20.1	18.2	18.5	$4U_2$	78.9	75.9	75.3
$3d_4$	30.5	27.6	26.5	$4U_3$	78.6	75.6	74.0
$3d_3$	27.1	24.5	26.3	$4p_{10}$	487	491	540
$3d_2$	8.71	8.42	8.76	$4p_9$	415	415	409
$3d_1''$	21.9	19.8	19.2	$4p_8$	398	398	391
$3d_1'$	19.4	17.5	17.4	$4p_7$	225	221	210
$3s_1''''$	19.0	17.2	17.2	$4p_6$	433	434	504
$3s_1'''$	17.9	16.2	16.1	$4p_3$	332	330	303
$3s_1''$	17.3	15.7	15.5	$4p_5$	728	750	456
$3s_1'$	11.9	11.2	11.3	$4p_4$	408	408	403
$3p_{10}$	161	153	169	$4p_2$	210	205	178
$3p_9$	127	121	121	$4p_1$	313	311	288
$3p_8$	133	126	125	$4s_5$	146	140	117
$3p_7$	92.7	87.8	89.2	$4s_4$	40.4	39.3	32.8
$3p_6$	127	121	118	$4s_3$	201	192	158
$3p_3$	103	97.6	89.9	$4s_2$	50.5	49.1	41.0
$3p_5$	175	166	110	$5d_6$	99.0	97.1	69.5
$3p_4$	118	112	99.4	$5d_5$	71.1	67.9	50.5
$3p_2$	87.2	82.6	81.8	$5d_4'$	119	117	107
$3p_1$	88.7	84.2	85.9	$5d_4$	167	164	204
$3s_5$	79.6	72.9	74.7	$5d_3$	73.8	72.2	71.1
$3s_4$	21.4	20.7	18.2	$5d_2$	33.6	31.6	33.4
$3s_3$	104	95.2	97.0	$5d_1''$	154	151	180
$3s_2$	24.9	23.9	22.2	$5d_1'$	115	113	118
$4d_6$	44.7	44.6	46.5	$5s_1''''$	104	102	97.7
$4d_5$	36.3	35.2	37.0	$5s_1'''$	98.9	97.1	98.3
$4d_4'$	53.2	53.2	53.9	$5s_1''$	181	178	125
$4d_4$	76.7	76.7	75.3	$5s_1'$	40.9	38.8	42.1

τ_{OA}: One-configuration approximation

τ_{MA}: Many-configuration approximation

τ_1 : Calculated with coulomb transition integrals.

τ_2 : Calculated with Hartree-Fock transition integrals

IC : Intermediate coupling

$J\ell$: $J\ell$-coupling scheme

(continued on next page

Tabular Data A-8.5. (concluded)

Lifetimes (in nsec) of ns levels of Ne.

Level	τ_{IC}	τ_{Jl}	Level	τ_{Jl}
$3s\ [3/2]^o_2$	∞	∞	$7s\ [3/2]^o_2$	283
$3s\ [3/2]^o_1$	24.4	2.75	$7s\ [3/1]^o_1$	64.6
$3s'\ [1/2]^o_0$	∞	∞	$7s'\ [1/2]^o_0$	292
$3s'\ [1/2]^o_1$	1.80	5.34	$7s'\ [1/2]^o_1$	106
$4s\ [3/2]^o_2$	39.4	38.8	$8s\ [3/2]^o_2$	460
$4s\ [3/2]^o_1$	11.0	8.04	$8s\ [3/2]^o_1$	107
$4s'\ [1/2]^o_0$	47.2	45.9	$8s'\ [1/2]^o_0$	476
$4s'\ [1/2]^o_1$	8.68	13.9	$8s'\ [1/2]^o_1$	175
$5s\ [3/2]^o_2$	79.0	82.3	$9s\ [3/2]^o_2$	777
$5s\ [3/2]^o_1$	21.4	19.0	$9s\ [3/2]^o_1$	153
$5s'\ [1/2]^o_0$	104	88.7	$9s'\ [1/2]^o_0$	800
$5s'\ [1/2]^o_1$	24.9	31.5	$9s'\ [1/2]^o_1$	256
$6s\ [3/2]^o_2$	146	160	$10s\ [3/2]^o_2$	1011
$6s\ [3/2]^o_1$	40.4	36.7	$10s\ [3/2]^o_1$	218
$6s'\ [1/2]^o_0$	201	168	$10s'\ [1/2]^o_0$	1034
$6s'\ [1/2]^o_1$	50.5	60.4	$10s'\ [1/2]^o_1$	360

Lifetimes (in nsec) of np levels of Ne.

Level	τ_{IC}	τ_{Jl}	Level	τ_{Jl}
$3p\ [1/2]_1$	26.2	26.6	$6p\ [1/2]_1$	1083
$3p\ [5/2]_3$	19.7	19.8	$6p\ [5/2]_3$	982
$3p\ [5/2]_2$	21.2	20.6	$6p\ [5/2]_2$	1025
$3p\ [3/2]_1$	20.5	19.3	$6p\ [3/2]_1$	978
$3p\ [3/2]_2$	20.9	17.6	$6p\ [3/2]_2$	913
$3p\ [1/2]_0$	16.4	16.9	$6p\ [1/2]_0$	744
$3p'\ [3/2]_1$	18.8	19.8	$6p'\ [3/2]_1$	992
$3p'\ [3/2]_2$	17.7	22.4	$6p'\ [3/2]_2$	1012
$3p'\ [1/2]_1$	16.3	20.1	$6p'\ [1/2]_1$	1028
$3p'\ [1/2]_0$	14.8	15.1	$6p'\ [1/2]_0$	847
$4p\ [1/2]_1$	161	145	$7p\ [1/2]_1$	1936
$4p\ [5/2]_3$	127	120	$7p\ [5/2]_3$	1816
$4p\ [5/2]_2$	133	127	$7p\ [5/2]_2$	1884
$4p\ [3/2]_1$	92.7	119	$7p\ [3/2]_1$	1818
$4p\ [3/2]_2$	127	108	$7p\ [3/2]_2$	1716
$4p\ [1/2]_0$	103	95.7	$7p\ [1/2]_0$	1415
$4p'\ [3/2]_1$	175	121	$7p'\ [3/2]_1$	1811
$4p'\ [3/2]_2$	118	127	$7p'\ [3/2]_2$	1855
$4p'\ [1/2]_1$	87.2	122	$7p'\ [1/2]_1$	1805
$4p'\ [1/2]_0$	88.7	90.7	$7p'\ [1/2]_0$	1465
$5p\ [1/2]_1$	487	457	$8p\ [1/2]_1$	4218
$5p\ [5/2]_3$	415	400	$8p\ [5/2]_3$	3714
$5p\ [5/2]_2$	398	421	$8p\ [5/2]_2$	3881
$5p\ [3/2]_1$	225	398	$8p\ [3/2]_1$	3790
$5p\ [3/2]_2$	433	367	$8p\ [3/2]_2$	3538
$5p\ [1/2]_0$	332	305	$8p\ [1/2]_0$	3332
$5p'\ [3/2]_1$	728	403	$8p'\ [3/2]_1$	3779
$5p'\ [3/2]_2$	408	414	$8p'\ [3/2]_2$	3840
$5p'\ [1/2]_1$	210	413	$8p'\ [1/2]_1$	3920
$5p'\ [1/2]_0$	313	324	$8p'\ [1/2]_0$	3463

Tabular Data A-8.6.

a) τ_{exp} (in nsec) for levels of the configurations $2p^5ns$, $2p^5md$ ($n = 3$-5, $m = 3, 4$) of Ne.

Level	1	2	3	4	5	6	Level	4	Level	4	Level	4	Level	7
$1s_4$	20		20.8	31.7	27.7		$2s_4$	9.67	$3s_4$	19.5	$3d_2$	7.25	—	—
$1s_2$	—	1.52	1.45	1.87	1.86	1.82	$2s_2$	7.78	$3s_2$	23.1	$3d_5$	13.2	$4d_4$	104
											$3s'_1$	12.3	—	—

b) τ_{exp} (in nsec) for levels of the configurations $2p^5np$ ($n = 3$-5) of Ne.

Level	8	9	10	11	7	12	13	14	Level	10	15	16	Level	15
$2p_{10}$	20	24.8	—	—	26	—	43	—	$3p_{10}$	65	80.4	—	$4p_{10}$	164
$2p_9$	17	19.4	22.5	—	24	19.5	30.5	29.3	—	—	—	—	—	—
$2p_8$	16	19.8	24.3	—	25	28.4	27.8	25.6	—	—	—	—	—	—
$2p_7$	13	19.9	20.3	—	22	—	20.2	16.8	—	—	—	—	—	—
$2p_6$	13	19.7	22	17	21	22	28.9	—	—	—	—	—	—	—
$2p_5$	12.5	17.6	23	—	18	28.2	25.4	18.8	—	—	—	—	—	—
$2p_4$	10.5	19.9	18.9	—	23	26.2	18.7	—	$3p_4$	—	150	—	—	—
$2p_3$	12	19.1	22	—	24	28.0	26.2	21.1	$3p_3$	—	—	60	—	—
$2p_2$	10	18.8	16.5	—	20	—	19.7	18.0	—	—	—	—	—	—
$2p_1$	8	14.4	14.7	—	14	14.8	14.4	14.9	$3p_1$	63.5	51.4	—	$4p_1$	157

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Probabilities of transitions (10^6 sec^{-1}) $2p^5 3p \rightarrow 2p^5 3s$ and $2p^5 ns \rightarrow 2p^5 3p$ (n = 4–6) in the spectrum of the neon atom

Transitions	A (3p → 3s) Calculated	A (3p → 3s) Experiment [illegible]	A (3p → 3s) Experiment [illegible]	A (4s → 3p) Calculated	A (5s → 3p) Calculated	A (5s → 3p) Experiment [illegible]	A (6s → 3p) Calculated
$3p'[1/2]_0 - ns'[1/2]^\circ_1$	75.6	70.6	73.0	0.92	0.33	0.255	0.15
$- ns\,[3/2]^\circ_1$	0.78	0.90	1.3	0.24	0.19	—	0.11
$3p'[1/2]_1 - ns'[1/2]^\circ_1$	24.8	22.5	24.4	4.56	1.35	1.39	0.61
$- ns'[1/2]^\circ_0$	17.2	14.1	17.3	6.11	1.94	—	0.90
$- ns\,[3/2]^\circ_1$	6.55	5.12	6.2	0.004	0.038	—	0.028
$- ns\,[3/2]^\circ_2$	13.2	10.2	12.2	0.61	0.22	—	0.11
$3p[1/2]_0 - ns'[1/2]^\circ_1$	0.42	0.34		0.77	0.34	0.345	0.18
$- ns\,[3/2]^\circ_1$	67.6	58.3	59.0	1.50	0.44	—	0.19
$3p'[3/2]_2 - ns'[1/2]^\circ_1$	25.6	23.1	26.4	11.3	3.47	3.39	1.80
$- ns\,[3/2]^\circ_1$	21.1	17.9	17.2	0.41	0.014	—	0.0008
$- ns\,[3/2]^\circ_2$	13.6	11.2	10.7	1.16	0.41	—	0.19
$3p'[3/2]_1 - ns'[1/2]^\circ_1$	24.4	21.7	25.6	2.99	0.69	0.639	0.29
$- ns'[1/2]^\circ_0$	27.9	25.4	23.5	11.5	3.50	—	1.61
$- ns\,[3/2]^\circ_1$	0.76	0.70		1.11	0.52	—	0.27
$- ns\,[3/2]^\circ_2$	3.90	3.49	3.9	0.21	0.073	—	0.034
$3p[3/2]_2 - ns'[1/2]^\circ_1$	19.5	17.4	21.1	3.73	0.69	0.609	0.27
$- ns\,[3/2]^\circ_1$	4.66	4.24	4.9	3.87	1.47	—	0.71
$- ns\,[3/2]^\circ_2$	32.9	28.5	27.6	3.79	1.22	—	0.57
$3p[3/2]_1 - ns'[1/2]^\circ_1$	2.0	1.98		0.27	0.22	0.228	0.12
$- ns'[1/2]^\circ_0$	11.8	10.6	15.4	6.82	1.89	—	0.85
$- ns\,[3/2]^\circ_1$	36.8	31.6	22.9	5.63	1.54	—	0.68
$- ns\,[3/2]^\circ_2$	7.16	6.01	9.5	0.55	0.17	—	0.079
$3p[5/2]_2 - ns'[1/2]^\circ_1$	3.16	3.21	4.5	0.19	0.24	0.200	0.14
$- ns\,[3/2]^\circ_1$	33.9	29.8	25.4	10.9	2.80	—	1.28
$- ns'[3/2]^\circ_2$	18.8	18.0	14.6	2.82	0.84	—	0.38
$3p[5/2]_3 - ns\,[3/2]^\circ_2$	58.3	50.6	—	13.4	3.87	—	1.76

Probabilities of transitions (10^6 sec^{-1}) $3p[1/2]_1 - ns$ (n = 3–6) in the spectrum of the neon atom

Transitions	A (3p[1/2]$_1$ → 3s) Calculated I	Calculated II	Experiment [1]	Experiment [2]	A (4s → 3p) Calculated I	Calculated II	A (5s → 3p) Calculated I	Calculated II	Experiment [3]	A (6s → 3p) Calculated I	Calculated II
$3p[1/2]_1 - ns'[1/2]^\circ_1$	0.12	0.12	0.12	—	1.57	0.96	0.49	0.40	0.283	0.23	0.20
$- ns'[1/2]^\circ_0$	2.65	2.30	2.42	3.8	3.93	2.40	0.86	0.70	—	0.37	0.32
$- ns\,[3/2]^\circ_1$	10.8	9.82	10.0	9.5	2.97	1.81	0.55	0.45	—	0.22	0.19
$- ns\,[3/2]^\circ_2$	28.8	25.0	25.3	20.6	5.80	3.50	1.30	1.13	—	0.61	0.53

Probabilities (10^6 cm^{-1}) of the $2p^5 4p \rightarrow 2p^5 ns$ (n = 3, 4) and $2p^5 ns \rightarrow 2p^5 4p$ (n = 5, 6) transitions in the spectrum of neon aton

Transition	A (4p → 3s) This paper	A (4p → 4s) This paper	A (4p → 4s) Murphy[4]	A (5s → 4p) This paper	A (5s → 4p) Murphy[4]	A (6s → 4p) This paper
$4p'[1/2]_0 - ns'[1/2]^\circ_1$	1.84	8.10	7.710	0.27	0.263	0.13
$- ns\,[3/2]^\circ_1$	0.005	0.80	0.667	0.015	0.013	0.018
$4p'[1/2]_1 - ns'[1/2]^\circ_1$	0.82	3.57	3.518	1.12	1.124	0.38
$- ns'[1/2]^\circ_0$	0.65	2.09	1.799	1.66	1.462	0.59
$- ns\,[3/2]^\circ_1$	0.34	0.042	0.042	0.002	0.002	0.003
$- ns\,[3/2]^\circ_2$	0.14	0.70	0.661	0.027	0.026	0.016
$4p[1/2]_0 - ns'[1/2]^\circ_1$	0.074	0.28	0.233	0.12	0.107	0.044
$- ns\,[3/2]^\circ_1$	1.95	7.34	7.021	0.32	0.312	0.14
$4p[3/2]_2 - ns'[1/2]^\circ_1$	1.14	5.55	5.265	3.01	2.671	1.03
$- ns\,[3/2]^\circ_1$	0.75	0.33	0.260	0.002	0.001	$4 \cdot 10^{-4}$
$- ns\,[3/2]^\circ_2$	0.029	0.14	0.176	0.009	0.011	0.005
$4p'[3/2]_1 - ns'[1/2]^\circ_1$	0.51	2.00	1.762	0.67	0.595	0.22
$- ns'[1/2]^\circ_0$	1.29	4.03	3.941	3.53	3.495	1.22
$- ns\,[3/2]^\circ_1$	0.15	0.001	0.002	0.005	0.008	0.005
$- ns\,[3/2]^\circ_2$	0.006	0.028	0.050	0.001	0.002	0.001
$4p[3/2]_2 - ns'[1/2]^\circ_1$	0.28	0.14	0.137	0.081	0.063	0.013
$- ns\,[3/2]^\circ_1$	0.29	1.70	1.731	0.85	0.882	0.30
$- ns\,[3/2]^\circ_2$	1.40	4.81	4.374	1.06	0.980	0.40
$4p[3/2]_1 - ns'[1/2]^\circ_1$	0.44	0.055	0.043	$5 \cdot 10^{-4}$	0.001	0.002
$- ns'[1/2]^\circ_0$	0.023	0.048	0.066	0.12	0.172	0.032
$- ns\,[3/2]^\circ_1$	1.11	4.89	4.573	1.44	1.364	0.50
$- ns\,[3/2]^\circ_2$	0.33	1.11	1.075	0.15	0.151	0.057
$4p[5/2]_2 - ns'[1/2]^\circ_1$	0.33	0.027	0.012	0.005	0.017	0.007
$- ns\,[3/2]^\circ_1$	0.96	3.82	3.527	2.27	2.105	0.74
$- ns'[3/2]^\circ_2$	0.61	1.93	1.948	0.54	0.556	0.19
$4p[5/2]_3 - ns\,[3/2]^\circ_2$	2.01	6.08	5.744	2.69	2.582	0.91
$4p[1/2]_1 - ns'[1/2]^\circ_1$	0.007	0.039	0.036	0.19	0.184	0.049
$- ns'[1/2]^\circ_0$	0.045	0.065	0.062	0.39	0.369	0.084
$- ns\,[3/2]^\circ_1$	0.37	0.77	0.750	0.46	0.459	0.12
$- ns\,[3/2]^\circ_2$	1.49	3.71	3.488	1.20	1.140	0.35

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Radiation lifetimes (in nsec) of the levels of the argon atom

Levels	τ_{OA}			τ_{MA}	Levels	τ_{OA}			τ_{MA}
	τ_r	τ_{rv}	τ_v			τ_r	τ_{rv}	τ_v	
$1s_4$	7.84	8.85	9.99	8.44	$4s_1''''$	430	365	310	297
$1s_2$	2.03	2.30	2.59	2.14	$4s_1'''$	441	374	317	367
$2p_{10}$	32.5	39.2	47.1	34.4	$4s_1''$	463	393	332	392
$2p_9$	23.2	28.0	33.7	27.5	$4s_1'$	1.62	1.71	1.80	3.78
$2p_8$	25.6	30.8	37.1	29.7	$3s_5$	76.9	84.7	93.2	84.5
$2p_7$	23.2	28.0	33.7	29.9	$3s_4$	17.6	20.4	23.7	5.73
$2p_6$	21.6	26.0	31.4	27.7	$3s_3$	76.7	84.5	92.9	87.7
$2p_5$	18.5	22.3	26.8	19.4	$3s_2$	34.5	28.3	32.7	32.6
$2p_4$	23.4	28.2	34.0	28.9	$4X_1$	31.6	37.6	44.5	43.3
$2p_3$	22.6	27.3	32.8	27.5	$4X_2$	41.9	49.7	58.9	48.3
$2p_2$	21.0	25.3	30.4	28.1	$4V_1$	38.3	45.5	53.8	46.9
$2p_1$	17.5	21.1	25.4	19.5	$4V_2$	35.1	41.7	49.4	45.4
$3d_6$	50.7	48.4	48.1	54.2	$4Y_1$	38.2	45.4	53.7	47.0
$3d_5$	37.4	36.5	35.6	40.8	$4Y_2$	48.4	57.3	67.8	51.0
$3d_4'$	53.3	50.8	48.5	52.0	$4U_1$	43.1	51.0	60.4	49.3
$3d_4$	52.7	50.2	47.9	50.8	$4U_2$	43.7	51.7	61.2	49.6
$3d_3$	50.9	48.6	46.3	57.6	$4W_1$	37.6	44.7	52.9	46.7
$3d_2$	3.51	3.66	3.81	9.0	$4W_2$	39.6	47.0	55.5	47.6
$3d_1''$	52.2	49.8	47.4	49.9	$4Z_1$	37.3	44.3	52.4	46.6
$3d_1'$	51.7	49.3	47.0	49.0	$4Z_2$	47.9	56.9	67.4	50.5
$3s_1''''$	52.0	49.6	47.3	49.9	$4p_{10}$	202	252	311	326
$3s_1'''$	51.7	49.3	47.0	49.7	$4p_9$	201	248	304	276
$3s_1''$	51.2	48.8	46.6	48.3	$4p_8$	221	272	333	291
$3s_1'$	0.91	0.95	1.00	3.36	$4p_7$	239	293	354	262
$2s_5$	39.4	43.6	48.3	42.1	$4p_6$	205	251	304	230
$2s_4$	8.46	9.79	11.3	4.74	$4p_5$	244	291	343	91.0
$2s_3$	39.3	43.5	48.2	43.9	$4p_4$	209	257	313	263
$2s_2$	9.51	11.0	12.7	3.20	$4p_3$	213	262	320	268
$3p_{10}$	112	132	154	155	$4p_2$	212	261	319	276
$3p_9$	101	118	137	124	$4p_1$	228	274	326	91.0
$3p_8$	110	129	150	134	$5d_6$	1919	1696	1454	352
$3p_7$	110	128	149	126	$5d_5$	223	231	237	111
$3p_6$	95.8	111	129	110	$5d_4'$	1649	1443	1232	1487
$3p_5$	93.8	108	124	65.0	$5d_4$	1475	1284	1093	1240
$3p_4$	105	123	143	127	$5d_3$	1570	1371	1169	631
$3p_3$	105	122	142	124	$5d_2$	4.82	5.12	5.42	2.69
$3p_2$	102	118	137	123	$5d_1''$	1296	1120	951	954
$3p_1$	94.9	109	125	62.0	$5d_1'$	1217	1050	891	848
$4d_6$	561	474	399	368	$5s_1''''$	1346	1166	990	514
$4d_5$	139	138	135	113	$5s_1'''$	1362	1181	1003	1088
$4d_4'$	515	436	368	460	$5s_1''$	1467	1276	1086	1221
$4d_4$	476	404	342	408	$5s_1'$	3.28	3.48	3.69	0.97
$4d_3$	501	424	358	372	$4s_5$	142	155	170	99.3
$4d_2$	4.19	4.42	4.65	10.0	$4s_4$	33.2	38.6	44.9	15.1
$4d_1''$	432	367	311	339	$4s_3$	141	155	170	99.2
$4d_1'$	408	347	294	314	$4s_2$	49.4	57.0	65.5	15.7

τ_r : From summation over transition probabilities obtained from dipole-length formula.

τ_v : From summation over transition probabilities obtained from dipole-velocity formula.

τ_{TV}: Geometric mean of τ_T and τ_v

τ_{MA}: Many-configuration approximation

τ_{OA}: One-configuration approximation

Tabular Data A-8.8.

Lifetimes of ns levels in Ar atom ($\times 10^{-9}$ sec)

Level	Intermediate coupling		τ_{JJ}	Level	τ_{JJ}
	τ_r	τ_{rv}			
$4s[3/2]^{\circ}_1$	7.84	8.85	2.50	$8s[3/2]^{\circ}_2$	298
$4s'[1/2]^{\circ}_1$	2.03	2.30	4.72	$8s[3/2]^{\circ}_1$	56.5
$5s[3/2]^{\circ}_2$	39.4	43.6	46.2	$8s'[1/2]^{\circ}_0$	305
$5s[3/2]^{\circ}_1$	8.46	9.79	7.50	$8s'[1/2]^{\circ}_1$	93.6
$5s'[1/2]^{\circ}_0$	39.3	43.5	54.4	$9s[3/2]^{\circ}_2$	480
$5s'[1/2]^{\circ}_1$	9.5	11.0	13.1	$9s[3/2]^{\circ}_1$	90
$6s[3/2]^{\circ}_2$	77.0	84.7	92.8	$9s'[1/2]^{\circ}_0$	490
$6s[3/2]^{\circ}_1$	17.6	20.4	17.2	$9s'[1/2]^{\circ}_1$	150
$6s'[1/2]^{\circ}_1$	76.7	84.5	99.5		
$6s'[1/2]^{\circ}_1$	24.5	29.3	28.8		
$7s[3/2]^{\circ}_2$	142	155	175		
$7s[3/2]^{\circ}_1$	33.2	38.6	32.5		
$7s'[1/2]^{\circ}_0$	141	155	180		
$7s'[1/2]^{\circ}_1$	49.4	57.0	54.3		

Lifetimes of np levels of Ar atom ($\times 10^{-9}$ sec)

Level	Intermediate coupling		τ_{JJ}	Level	τ_{JJ}
	τ_r	τ_{rv}			
$4p[1/2]_1$	32.5	39.2	43.5	$7p[1/2]_1$	410
$4p[5/2]_3$	23.2	28.0	29.8	$7p[5/2]_3$	444
$4p[5/2]_2$	25.6	30.8	32.9	$7p[5/2]_2$	494
$4p[3/2]_1$	23.2	28.0	29.0	$7p[3/3]_1$	517
$4p[3/2]_2$	21.6	26.8	25.2	$7p'[3/2]_2$	464
$4p[1/2]_0$	18.5	22.3	23.7	$7p[1/2]_0$	375
$4p'[3/2]_1$	23.4	28.2	29.9	$7p[3/2]_1$	459
$4p'[3/2]_2$	22.6	27.3	33.2	$7p'[3/2]_2$	469
$4p'[1/2]_1$	21.0	25.3	29.3	$7p'[1/2]_1$	432
$4p'[1/2]_0$	17.5	21.1	23.6	$7p'[1/2]_0$	509
$5p[1/2]_1$	112	132	114	$8p[1/2]_1$	687
$5p[5/2]_3$	101	118	115	$8p[5/2]_3$	730
$5p[5/2]_2$	110	129	126	$8p[5/2]_2$	842
$5p[3/2]_1$	110	128	119	$8p[3/2]_1$	878
$5p[3/2]_2$	95.8	111	102	$8p[3/2]_2$	798
$5p[1/2]_0$	93.8	108	82.5	$8p[1/2]_0$	617
$5p'[3/2]_1$	105	123	122	$8p'[3/2]_1$	753
$5p'[3/2]_2$	105	122	126	$8p'[3/2]_2$	778
$5p'[1/2]_1$	102	118	128	$8p'[1/2]_1$	740
$5p'[1/2]_0$	95.0	109	107	$8p'[1/2]_0$	896
$6p[1/2]_1$	202	252	227		
$6p[5/2]_3$	201	248	249		
$6p[5/2]_2$	221	272	277		
$6p[3/2]_1$	239	293	281		
$6p[3/2]_2$	205	251	245		
$6p[1/2]_0$	244	291	192		
$6p'[3/2]_1$	209	257	266		
$6p'[3/2]_2$	213	262	281		
$6p'[1/2]_1$	212	261	278		
$6p'[1/2]_0$	228	274	274		

Tabular Data A-8.9.

Values of $\tau_{exper.}$ (nsec) for levels of the argon atom

Level	$\tau_{exper.}$	Level	$\tau_{exper.}$
$1s_4$	8.60 [illegible] 1	$2s_1$	17.5 [illegible] 1
$1s_2$	2.15 [illegible] 1	$2s_4$	10.1 [illegible] 1
$2p_{10}$	31.6 [illegible] 2	$3p_{10}$	189 [illegible] 5
$2p_9$	20.0 [illegible], 22 [illegible] 2, 3	$3p_9$	111 [illegible] 5
$2p_3$	26 [illegible], 25 [illegible] 4, 3	$3p_8$	166 [illegible], 158 [illegible] 5, 3
$2p_6$	31 [illegible], 28 [illegible] 4, 3	$3p_7$	149 [illegible], 190 [illegible] 5, 3
$2p_2$	25 [illegible], 28 [illegible] 4, 3	$3p_6$	124 [illegible], 200 [illegible] 5, 3
$2p_1$	21 [illegible], 20 [illegible] 4, 3	$3p_3$	174 [illegible] 3
$3d_6$	94 [illegible] 1	$3p_5$	95 [illegible], 97 [illegible] 5, 3
$3d_3$	3.48 [illegible] 1	$3p_1$	71 [illegible], 106 [illegible] 5, 3
$3s'_1$	3.0 [illegible] 1	$4d_4$	24 [illegible] 1

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Table taken from "Radiation lifetimes of levels of the argon atom," Opt. Spectros. 38,234 P. F. Gruzdev and A. V. Loginov (1975).

Tabular Data A-8.10.

Lifetimes of levels in the Kr I atom (in nsec)

Level	τ_{SC}			τ_{MC}	Level	τ_{SC}			τ_{MC}
	τ_r	τ_{rv}	τ_v			τ_r	τ_{rv}	τ_v	
$1s_5$	3.38	3.79	4.26	3.61	$4s_1''''$	528	522	476	420
$1s_4$	3.22	3.61	4.06	3.45	$4s_1'''$	596	588	538	553
$2p_{10}$	27.4	35.5	46.0	29.7	$4s_1''$	624	625	579	512
$2p_9$	20.7	26.8	34.7	25.9	$4s_1'$	1.70	1.83	1.97	1.35
$2p_8$	23.8	30.9	40.1	29.5	$3s_5$	82.2	92.0	103	89.4
$2p_7$	20.9	27.1	35.1	29.7	$3s_4$	17.4	20.3	23.7	10.1
$2p_6$	18.1	23.4	30.3	26.3	$3s_3$	81.4	91.0	102	87.4
$2p_5$	16.8	21.8	28.3	18.9	$3s_2$	25.0	29.1	33.7	
$2p_4$	21.6	28.0	36.4	28.8	$4X_1$	23.8	30.1	37.9	37.3
$2p_3$	21.2	27.5	35.6	26.9	$4Z_2$	34.2	43.1	54.2	42.0
$2p_2$	19.3	25.0	32.4	28.6	$4V_4$	30.8	38.9	48.9	40.5
$2p_1$	17.2	22.3	28.9	19.0	$4V_5$	27.4	34.6	43.6	39.3
$3d_6$	124	108	94.6	118	$4T_3$	30.8	38.9	48.9	41.0
$3d_5$	37.5	37.3	36.8	44.5	$4Y_3$	41.2	51.9	65.2	44.5
$3d_4'$	125	109	95.2	114	$4W_3$	35.7	45.0	56.6	42.8
$3d_4$	113	98.4	85.8	100	$4W_4$	36.5	46.0	57.8	43.3
$3d_3$	114	99.6	86.9	116	$4V_3$	28.9	36.5	46.1	40.3
$3d_2$	1.23	1.30	1.38	1.87	$4S_2$	39.0	49.7	62.9	43.9
$3d_1''$	103	90.1	78.6	89.8	$4S_3$	29.5	37.3	47.0	40.3
$3d_1'$	102	88.6	77.2	87.9	$4V_4$	31.9	40.2	50.6	41.3
$3s_1''''$	104	90.8	79.2	98.0	$4p_{10}$	173	206	242	299
$3s_1'''$	111	96.5	84.1	101	$4p_9$	175	207	243	246
$3s_1''$	111	97.0	84.5	102	$4p_8$	198	234	274	251
$3s_1'$	0.84	0.89	0.95		$4p_7$	221	261	305	218
$2s_5$	41.9	47.3	53.3	47.5	$4p_6$	185	218	256	213
$2s_4$	7.75	9.04	10.5	17.7	$4p_5$	262	304	349	
$2s_3$	41.5	46.8	52.8	52.6	$4p_4$	185	218	255	242
$2s_2$	10.6	12.3	14.4		$4p_3$	184	216	252	220
$3p_{10}$	84.6	104	127	122	$4p_2$	171	201	234	215
$3p_9$	80.6	98.4	119	107	$4p_1$	184	211	238	
$3p_8$	91.1	111	135	117	$5d_6$	556	669	786	425
$3p_7$	95.1	115	139	109	$5d_5$	129	143	157	172
$3p_6$	79.8	96.8	117	99.7	$5d_4'$	509	669	762	656
$3p_5$	92.5	111	131	54.1	$5d_4$	544	628	699	619
$3p_4$	86.8	106	128	113	$5d_3$	555	646	726	425
$3p_3$	84.4	103	124	105	$5d_2$	2.81	3.15	3.41	2.37
$3p_2$	80.2	97.3	117	108	$5d_1''$	540	609	659	536
$3p_1$	83.2	99.3	117	52.7	$5d_1'$	533	597	640	551
$4d_6$	806	873	870	203	$5s_1''''$	514	578	624	382
$4d_5$	86.3	92.7	98.6		$5s_1'''$	542	618	677	663
$4d_4'$	739	760	723	515	$5s_1''$	544	628	698	612
$4d_4$	639	635	586	467	$5s_1'$	3.57	3.86	4.17	1.05
$4d_3$	674	678	633	310	$4s_5$	151	167	185	106
$4d_2$	1.81	1.95	2.09	1.68	$4s_4$	33.2	38.8	45.4	15.2
$4d_1''$	564	540	484	471	$4s_3$	150	166	183	97.4
$4d_1'$	542	514	457	528	$4s_2$	48.5	56.3	65.3	

τ_r: obtained from transition probabilities calculated using dipole-length formula.

τ_V: obtained from transition probabilities calculated using dipole-velocity formula.

$\tau_{rV} = (\tau_r \tau_V)^{1/2}$, geometric mean.

SC: single-configuration approximation.

MC: multiple-configuration approximation.

Reference: "Radiation lifetimes of levels of the Kr I atom"
P. F. Grugder and A. L. Loginov, Opt. Spectros. 38,611 (1975).

Tabular Data A-8.11.

Level radiation lifetimes (in nsec) of the spectrum of the xenon atom.

Level	τ_{oa}			τ_{ma}	Level	τ_{oa}			τ_{ma}
	τ_R	τ_{RV}	τ_V			τ_R	τ_{RV}	τ_V	
1	2	3	4	5	1	2	3	4	5
$1s_5$	4.06	4.59	5.18	4.16	$4s''''_1$	97.2	102	90.1	93.4
$1s_4$	3.64	4.11	4.65	4.29	$4s'''_1$	1.04	1.14	1.22	1.19
$2p_{10}$	29.7	43.5	63.6	32.5	$4s''_1$	105	120	129	96.5
$2p_9$	28.6	41.8	61.1	39.5	$4s'_1$	106	120	125	118
$2p_8$	22.0	32.2	47.1	29.9	$3s_5$	92.3	102	113	108
$2p_7$	24.6	36.0	52.6	41.5	$3s_4$	19.4	23.1	27.5	66.0
$2p_6$	19.2	28.1	41.2	34.5	$3s_3$	87.6	96.7	106	91.6
$2p_5$	29.5	29.9	43.7	24.5	$3s_2$	24.7	29.3	34.5	—
$2p_4$	17.5	25.4	36.8	39.2	$4f\,^3D_1$	14.8	19.0	24.2	30.9
$2p_3$	16.5	24.0	34.4	26.5	$4f\,^3D_3$	25.9	33.1	42.0	34.5
$2p_2$	14.9	21.6	30.8	31.9	$4f\,^1G_4$	23.9	30.4	38.6	32.8
$2p_1$	14.1	20.0	27.5	18.4	$4f\,^3G_5$	19.1	24.5	31.1	32.4
$3d_6$	8490	5765	3910	2670	$4f\,^3F_3$	22.8	29.1	36.9	34.1
$3d_5$	56.3	60.5	64.7	—	$4f\,^1D_2$	35.8	45.7	58.0	37.4
$3d'_4$	2910	1980	1340	2410	$4f\,^1F_3$	28.8	36.7	46.5	34.7
$3d_4$	1240	841	571	899	$4f\,^3F_4$	30.8	39.2	49.7	36.0
$3d_3$	1610	1093	742	1559	$4f\,^3D_2$	19.8	25.4	32.3	33.0
$3d_2$	0.83	0.89	0.96	1.69	$4f\,^3F_2$	25.8	34.1	44.0	37.0
$3d''_1$	661	449	305	452	$4f\,^3G_3$	20.7	26.5	33.7	32.7
$3d'_1$	513	348	237	343	$4f\,^3G_4$	24.8	31.7	40.3	34.3
$3s''''_1$	384	261	177	206	$4p_{10}$	196	221	243	249
$3s'''_1$	0.30	0.32	0.35	[illegible]	$4p_9$	241	276	307	322
$3s''_1$	806	547	372	547	$4p_8$	204	232	259	335
$3s'_1$	634	431	292	316	$4p_7$	276	321	364	147
$2s_5$	48.5	54.2	60.6	54.2	$4p_6$	224	256	292	239
$2s_4$	8.85	10.5	12.5	12.1	$4p_5$	369	452	540	—
$2s_3$	46.4	51.9	58.1	52.3	$4p_4$	188	201	206	155
$2s_2$	11.0	13.0	15.4	—	$4p_3$	204	225	239	142
$3p_{10}$	89.6	107	125	69.2	$4p_2$	170	184	190	91.2
$3p_9$	107	130	156	108	$4p_1$	115	108	96.5	—
$3p_8$	88.5	107	128	147	$5d_6$	118	141	164	139
$3p_7$	112	139	169	—	$5d_5$	74.8	87.1	99.0	—
$3p_6$	90.7	111	135	100	$5d'_4$	128	152	473	143
$3p_5$	118	153	194	—	$5d_4$	122	145	163	168
$3p_4$	88.1	94.0	83.5	99.0	$5d_3$	128	152	168	170
$3p_3$	88.8	98.6	93.9	82.4	$5d_2$	2.41	2.70	3.00	—
$3p_2$	76.4	80.3	69.6	62.5	$5d''_1$	126	150	170	186
$3p_1$	61.3	47.6	28.0	25.0	$5d'_1$	130	153	166	162
$4d_6$	110	129	153	77.5	$5s''''_1$	120	138	147	126
$4d_5$	53.4	61.0	69.6	79.5	$5s'''_1$	2.62	2.92	3.23	—
$4d'_4$	116	137	161	93.9	$5s''_1$	122	144	161	133
$4d_4$	107	126	147	103	$5s'_1$	126	148	161	143
$4d_3$	112	132	154	88.2	$4s_5$	156	175	196	115
$4d_2$	1.30	1.44	1.58	—	$4s_4$	36.0	43.1	51.4	33.4
$4d''_1$	109	127	147	127	$4s_3$	118	141	164	86.9
$4d'_1$	109	126	143	170	$4s_2$	74.9	87.1	99.0	—

τ_R = dipole-length approximation

τ_V = dipole-velocity approximation

$\tau_{RV} = (\tau_R \tau_V)^{1/2}$ geometric mean

Reference: "Radiation lifetimes of xenon levels" A. V. Loginov and P. F. Gruzdev: Opt. Spectros. 41, 104 (1976)

Tabular Data A-8.11.

(Concluded)

Comparison of τ_{calc} and τ_{exp} for the levels of the xenon atom.

Level	τ_{calc} (nsec)				τ_{exp} (nsec)
	$\tau_{r\psi}$(present study)	τ_{Π} (Ref.4)	τ_r (Ref.11)	τ_ψ (Ref.11)	
$1s_4$	4.59				3.31 [2], 3.70 [3], 4.29 [9]
$1s_5$	4.11				3.17 [2], 3.29 [3], 3.91 [7], 4.20 [9]
$2p_8$	32.2	33.0	24.7	34.4	32.7 [1]
$2p_7$	36.0	35.0	29.0	35.2	35.9 [10]
$2p_6$	28.1	27.1	27.4	31.7	33 [4], 38.8 [10], 48 [8]
$2p_5$	29.9	27.0	24.7	32.3	30 [8], 40 [4]
$2p_4$	25.4	28.7	37.2	48.8	38.1 [10]
$2p_3$	24.0	28.0	26.3	35.6	30.5 [12], 34 [5], 39.0 [4]
$2p_2$	21.6	24.8	23.9	36.1	29.5 [13], 35 [5], 43.5 [4]
$2p_1$	20.0	23.0	27.2	35.0	30 [5], 30.7 [14], 38.5 [4]
$3p_{10}$	107	155			143 [4], 156 [13]
$3p_9$	130	140			168 [13], 200 [4]
$3p_8$	107	115			141 [4], 150 [8], 163 [12], 183 [13]
$3p_7$	139	125			100 [13], 101 [4], 203 [5]
$3p_6$	111	112			107 [13], 140 [8], 155 [6], 156 [4], 169 [12]
$3p_5$	153	118			87 [4], 107 [13], 115 [5]
$4p_8$	232	550			275 [4], 419 [13], 420 [12]
$4p_7$	321				350 [13]
$4p_6$	259				285 [13], 290 [13]
$4p_5$	452				171 [13]
$3d'$	1980	5250			8000 [12]
$5d_5$	87.1	114			87 [4]

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Tabular Data A-8.12.

Transition probabilities and excitation cross sections of Xe II

Transition	λ(Å)	A_{ki} (10^8 sec^{-1}) Our data	A_{ki} (10^8 sec^{-1}) Ref.	Q'_k (10^{-19} cm^2)	$\Sigma_{casc.}/Q'_k$	q_k (10^{-19} cm^2)
$5d\,^4D_{7/2}-6p\,^4P^0_{5/2}$	6278	0.079	—	169.7	0.445	94.14
$5d\,^4D_{5/2}$	6051	0.080	1.93			
$6s\,^4P_{3/2}$	5292	0.082	1.77			
$5d\,^4D_{5/2}-6p\,^4D^0_{3/2}$	4675	0.029	0.118	184.9	1.25	46.43
$6s\,^4P_{5/2}$	4603	0.122	0.49			
$5d\,^4D_{1/2}-6p\,^4D^0_{1/2}$	5473	0.040	0.61	82.3	0.188	66.88
$6s\,^4P_{3/2}$	4844	0.127	1.66			
$5d\,^4P_{3/2}-6p\,^4S^0_{3/2}$	6597	0.15	—	147	0.190	118.96
$6s\,^4P_{1/2}$	4684	0.172	—			
$6s\,^4P_{5/2}$	3763	0.0064	—			
$5d\,^2D_{3/2}-6p\,^2P^0_{1/2}$	6513	0.058	—	217.6	0.557	96.6
$5d\,^4P_{3/2}$	6115	0.083	—			
$6s\,^2P_{1/2}$	5260	0.056	0.058			
$6s\,^4D_{1/2}$	4524	0.0233	0.20			
$5d'\,^2F_{7/2}-6p'\,^2F^0_{7/2}$	6599	0.049	—	196.5	0.348	128.11
$6s'\,^2D_{5/2}$	4532	0.0135	—			
$6s'\,^2D_{5/2}-6p'\,^2F^0_{5/2}$	6271	0.076	—	206.8	—	—
$5d'\,^2D_{5/2}$	5700	0.0383	—			
$5d\,^2D_{5/2}$	4769	0.0123	—			
$6p\,^4P^0_{5/2}-7s\,^4P_{5/2}$	4823	0.049	—	69.9	—	—
$6s'\,^2D_{3/2}-6p'\,^2P^0_{3/2}$	5971	0.0556	—	63.4	0.625	23.82
$6s'\,^2D_{5/2}$	4616	0.0264	—			
$6s\,^4P_{1/2}$	3507	0.0135	—			
$6s\,^2P_{3/2}$	3721	0.0184	—			
$6p\,^4P^0_{3/2}-6d\,^4D_{5/2}$	4209	0.283	—	13.2	—	—
$6p\,^4P^0_{5/2}$	4180	0.132	—			
$6p\,^4P^0_{3/2}-6d\,^4D_{3/2}$	4208	0.135	—	23.1	—	—
$6p\,^4D^0_{7/2}-6d\,^4D_{7/2}$	5339	0.238	—	38.8	—	—
$6p\,^4D^0_{5/2}$	4585	0.0424	—			
$6p\,^4D^0_{5/2}$	4331	0.337	—	14.7	—	—
$5d\,^2D_{5/2}-6p'\,^2D^0_{5/2}$	4415	0.072	—	35.4	0.667	11.8
$5d\,^2D_{3/2}$	4114	0.0293	—			
$6p\,^4D^0_{7/2}-6d\,^4P_{5/2}$	3367	0.21	—	3.7	—	—
$6p\,^4S^0_{3/2}-7s'\,^2D_{5/2}$	4057	0.00047	—	97.5	—	—

Reference:

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Reference:

"Transition Probabilities and Cross Sections for Excitation of Xe II". V.P. Samoilow, Yu. M. Smionov and G.S. Starikova, Opt. Spectos. 38, 707 (1975).

Tabular Data A-8.13.

ARGON 4p, 4p' LEVELS

Level	Chang, Setser	Radiative Lifetimes (nsec) Lilly (T)	Kloze (E)	Shumaker et al (E)	Grandin et al (E)
$2p_1$, $4p'[1/2]_0$	—	22.6	21	19.5	—
$2p_1$, $4p'[1/2]_1$	26.5	25.7	25	24.2	—
$2p_3$, $4p'[3/2]_2$	27.7	27.6	26	24.9	—
$2p_4$, $4p'[3/2]_1$	33.2	29.0	31	26.5	37.0
$2p_5$, $4p[1/2]_0$	—	22.8	—	21.6	—
$2p_6$, $4p[3/2]_2$	26.6	26.9	—	24.4	33.4
$2p_7$, $4p[3/2]_1$	29.8	28.7	—	24.8	32.9
$2p_8$, $4p[5/2]_2$	32.8	31.4	—	26.8	—
$2p_9$, $4p[5/2]_3$	30.1	28.6	—	25.3	36.5
$2p_{10}$, $4p[1/2]_1$	41.7	43.3	—	32.4	—

Tabular Data A-8.14.

KRYPTON 5P, 5P' LEVELS

RADIATIVE LIFETIMES (NSEC)

LEVEL	CHANG, SETSER	LILLY (T)	MURPHY (T)	LANDMAN, DOBRIN (E)
$2p_1$, $5p'[1/2]_0$	—	24.2	24.2	—
$2p_2$, $5p'[3/2]_2$	26.9	28.8	28.8	—
$2p_3$, $5p'[1/2]_1$	26.7	26.2	26.3	—
$2p_4$, $5p'[3/2]_1$	—	30.4	30.3	—
$2p_5$, $5p[1/2]_0$	—	23.4	23.4	—
$2p_6$, $5p[3/2]_2$	25.4	25.2	25.4	30.2
$2p_7$, $5p[3/2]_1$	26.5	29.9	29.9	—
$2p_8$, $5p[5/2]_2$	25.2	33.8	33.6	—
$2p_9$, $5p[5/2]_3$	28.7	28.5	28.5	28.1
$2p_{10}$, $5p[1/2]_1$	—	40.0	40.0	—

T: Theory, E: Experiment

(This refers to both A-8.13. and A-8.14)

References

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D.A. Landman and R. Dobrin, Phys. Rev. A 8, 1868 (1973).

Tabular Data A-8.15.

Table 1 *

Compilation of lifetimes and oscillator strengths for the two transitions $^3P_1 \to {}^1S_0$ and $^1P_1 \to {}^1S_0$ in krypton

$^3\tau$ (ns)	^3f (1263 A)	$^1\tau$ (ns)	^1f (1165 A)	Method	Ref.
4.14	0.166			resonance imprisonment	[1]
4.32 ± 0.33	0.159 ± 0.01	4.52 ± 0.35	0.135 ± 0.01	total absorption	[2]
3.3 ± 0.8	0.21 ± 0.05	2.9 ± 0.7	0.21 ± 0.05	linear absorption	[3]
3.37 ± 0.33	0.204 ± 0.020	3.32 ± 0.36	0.184 ± 0.020	optical line broadening	[4]
3.67 ± 0.12	0.187 ± 0.006	3.16 ± 0.15	0.193 ± 0.009	total absorption	[5]
4.0 ± 0.8	0.173 ± 0.035	3.5 ± 0.7	0.173 ± 0.035	electron energy loss	[6]
		4.2 ± 0.4	0.142 ± 0.015	self-absorption	[7]
3.18 ± 0.12	0.208 ± 0.006	3.11 ± 0.12	0.197 ± 0.006	resonance fluorescence	[8]
4.98	0.138	4.49	0.136	nonrelativistic Hartree–Fock	[9]
3.43	0.20	3.05	0.20	intermediate coupling calculation	[10]
3.61	0.190	3.45	0.177	multiple configuration approximation	[11]

Table 2 *

Compilation of lifetimes and oscillator strengths for the two transitions $^3P_1 \to {}^1S_0$ and $^1P_1 \to {}^1S_0$ in xenon

$^3\tau$ (ns)	^3f (1470 A)	$^1\tau$ (ns)	^1f (1296 A)	Method	Ref.
3.79 ± 0.12	0.256 ± 0.008	3.17 ± 0.19	0.238 ± 0.015	zero field level crossing	[12]
3.5 ± 0.6	0.28 ± 0.05	3.3 ± 0.7	0.23 ± 0.05	linear absorption	[13]
3.74 ± 0.25	0.260 ± 0.20	2.80 ± 0.20	0.270 ± 0.020	total absorption	[14]
		3.89 ± 0.10	0.194 ± 0.005	total absorption	[5]
3.73 ± 0.75	0.260 ± 0.052	4.0 ± 0.8	0.190 ± 0.038	electron energy loss	[4]
3.57	0.272	3.99	0.189	low-energy electron impact	[15]
4.6 ± 0.5	0.213 ± 0.020	4.2 ± 0.9	0.180 ± 0.040	resonance imprisonment	[16]
5.31	0.183	4.47	0.169	low-energy electron impact	[17]
3.46 ± 0.09	0.263 ± 0.007	3.44 ± 0.07	0.229 ± 0.007	resonance fluorescence	[8]
5.00	0.194	5.13	0.147	nonrelativistic Hartree–Fock	[9]
3.47	0.28	3.02	0.25	intermediate coupling calculation	[10]
4.58	0.212	3.99	0.189	nonrelativistic Hartree–Fock	[18]

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* Taken from reference 8.

Tabular Data A-8.16. Molecular xenon fluorescence lifetimes reported in the literature.

State	Ref.[1]	Ref.[2]	Ref.[3]	Ref.[4]	Ref.[5]	Ref.[6]	Ref.[7]
$(^3\Sigma_u^+)1u$		16	96			99	46-60
$(^1\Sigma_u^+)0_u^+$		4	5.5	16			1.8-3
$(^3\Sigma_g^+)1g$	500				200		$\gtrsim 150^{a)}$
$(^1\Sigma_g^+)0_g^+$							$\gtrsim 500^{a)}$

a) These values correspond to the overall decay rates in nanoseconds.

References

[1] R. Boucique and P. Mortier, J. Phys. D 3 (1970) 1905.
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[3] J.W. Keto, R.E. Claeson, Jr. and G.K. Walters, Phys. Rev. Letters 33 (1974) 1365.
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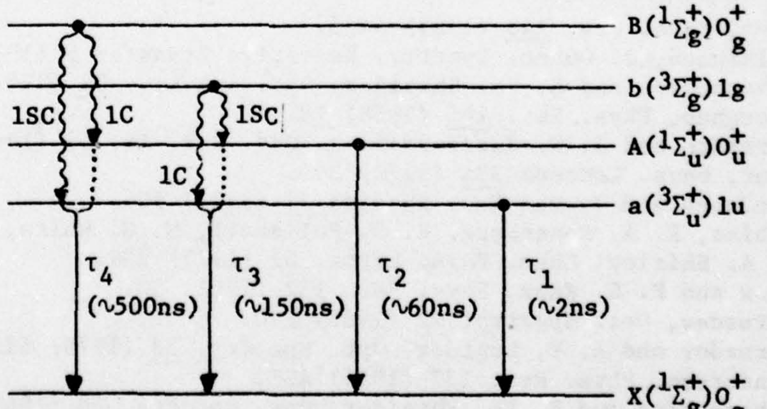
[6] P.K. Leichner, K.F. Palmer, J.D. Cook and M. Thieneman, Phys. Rev. A 13 (1976) 1787.
[7] M. Ghelfenstein, R. López-Delgado and H. Szwarc, Chem. Phys. Letters 49 (1977) 312.



Assignments for the four fluorescence components in xenon vapor (ref. 8)

[8] M. Ghelfenstein, H. Szwarc and R. López-Delgado, Chem. Phys. Letts 52 (1977) 238.

* Taken from ref. 8.

A-9. ELECTRON AFFINITIES

CONTENTS

Tabular Data. A-9.1. Electron Affinities (in eV)

He	< 0	Recommended values from Table 10 in the critical review: H. Hotop and W.C. Lineberger, "Binding Energies in Atomic Negative Ions," Jour. Phys. Chem. Ref. Data 4, 539-576 (1975).
Ne	< 0	
Ar	< 0	
Kr	< 0	
Xe	< 0	
F	3.399 (3)	
Cl	3.615 (4)	
Br	3.364 (4)	
I	3.061 (4)	
F_2	3.08 ± 0.1	W.A. Chupka, J. Berkowitz, and D. Gutman, J. Chem. Phys. 55, 2724 (1971).
Cl_2	2.38 ± 0.1	
Br_2	2.51 ± 0.1	
I_2	2.58 ± 0.1	
IBr	2.7 ± 0.2 eV	
ICl	1.43	J. Jortner and U. Sokolov, Nature 190, 1003 (1961).

For discussions of the difference between electron affinities and vertical detachment energies for molecules, see H.S.W. Massey, "Negative Ions,"(Third Edition) Cambridge Univ. Press, Cambridge (1976), pg. 166 and E.W. McDaniel, "Collision Phenomena in Ionized Gases," Wiley, New York (1964), pg. 379.

Tabular Data A-9.2.
Molecular xenon fluorescence lifetimes reported in the literature

State	Ref.[1]	Ref.[2]	Ref.[3]	Ref.[4]	Ref.[5]	Ref.[6]	Ref.[7]
$(^3\Sigma_u^+)1u$		16	96			99	46-60
$(^1\Sigma_u^+)0_u^+$		4	5.5	16			1.8-3
$(^3\Sigma_g^+)1g$	500				200		$\gtrsim$150[a)]
$(^1\Sigma_g^+)0_g^+$							$\gtrsim$500[a)]

a) These values correspond to the overall decay rates in nanoseconds.

Excimer	Mean Lifetimes (10^{-6} secs)	Reference
Ar_2^*	3.7	[1]
	2.8	[9]
$a(^3\Sigma_u)1u$	3.2	[3]
$A(^1\Sigma_u^+)0_u^+$	4.2 10^{-3}	[3]
Kr_2^*	1.7	[1]

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[2] H.A. Koehler, L.J. Ferderber, D.L. Redhead and P.J. Ebert, Phys. Rev. A 9 (1973) 768
[3] J.W. Keto, R.E. Claeson, Jr. and G.K. Walters, Phys. Rev. Letters 33 (1974) 1365.
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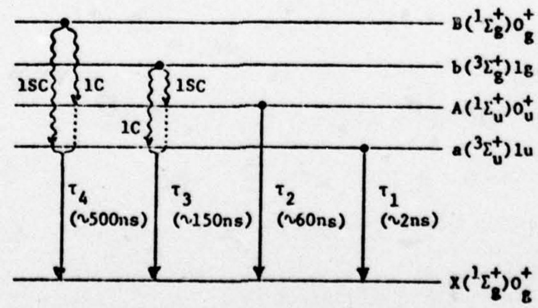
[6] P.K. Leichner, K.F. Palmer, J.D. Cook and M. Thieneman, Phys. Rev. A 13 (1976) 1787.
[7] M. Ghelfenstein, R. López-Delgado and H. Szwarc, Chem. Phys. Letters 49 (1977) 312.



Assignments for the four fluorescence components in xenon vapor (ref. 8)

[8] M. Ghelfenstein, H. Szwarc and R. López-Delgado, Chem. Phys. Letts 52 (1977) 238.
[9] N. Thonnard and G.S. Hurst, Phys. Rev. A 5 (1972) 1110.

* Taken from ref. 8.

A-10. POLARIZABILITIES AND MULTIPOLE MOMENTS

CONTENTS

Tabulated Data A-10.1. Recommended values for the polarizabilities of ground state atoms in units of $10^{-24}cm^3$.

Atom	Average Polarizability
He	0.204956
F	0.557
Ne	0.395
Cl	2.18
Ar	1.64
Br	2.7
Kr	2.48
I	3.9
Xe	4.04

From T.M. Miller and B. Bederson, "Atomic and Molecular Polarizabilities-A Review of Recent Advances," in "Advances in Atomic and Molecular Physics" (D.R. Bates and B. Bederson, Eds.), Vol. 13, Academic Press, New York (1977).

Tabulated Data A-10.2. Measured values of the polarizabilities $\alpha_{zz}(m_J=1)$ and $\alpha_{zz}(m_J=2)$ of the $^3P_2$ metastable noble gas atoms in units of $10^{-24}cm^3$).

Ne^*	$\alpha_{zz}(1)$	28.4 ± 0.6
	$\alpha_{zz}(2)$	26.7 ± 0.5
Ar^*	$\alpha_{zz}(1)$	49.5 ± 1.0
	$\alpha_{zz}(2)$	44.7 ± 0.9
Kr^*	$\alpha_{zz}(1)$	52.7 ± 1.0
	$\alpha_{zz}(2)$	46.8 ± 0.9
Xe^*	$\alpha_{zz}(1)$	66.6 ± 1.3
	$\alpha_{zz}(2)$	57.4 ± 1.1

Data from R.W. Molof, H.L. Schwartz, T.M. Miller, and B. Bederson, Phys. Rev. A. 10, 1131 (1974). (See pages 43-47 of the review by Miller and Bederson).

For data on 2^3S_1 and 2^1S_0 metastable helium, see D.A. Crosby and J.C. Zorn, Phys. 16, 488 (1977).

Tabulated Data A-10.3. Polarizabilities of Atoms.

Atom	Quadrupole Polarizability α_q ($Å^5$)	Dipole Hyperpolarizability γ (10^{-38} e.s.u.)
He	0.101	1.82*
Ne	0.370	
Ar	2.19	
H	0.622	
Li	60.0	
Na	74.8	
K	212	
Rb	261	
Cs	441	
Be	9.1	

The above values are from "The Mobility and Diffusion of Ions in Gases" by E. W. McDaniel and E. A. Mason, Wiley, N.Y., (1973), Appendix II except for *"The Numerical Determination of Dipole Hyperpolarizabilities", R. F. Stewart, Mol. Phys. 27 (No. 3) pp. 779-783 (1974).

Tabulated Data A-10.4. Computed dynamic polarizabilities for He.

Frequency (a.u.)	Wavelength (Å)	Dynamic polarizability (a.u.)
0.00	∞	1.322
0.02	3629	1.344
0.04	1814	1.417
0.06	1210	1.562
0.08	907	1.842
0.10	726	2.482
0.120	605	5.841
0.1269	571.8	2555.06
0.128	567	-21.245

Above from "Fully Coupled Hartree-Fock calculations of the Refractive Index, Dynamic Polarizability, and Verdet Coefficients of He, Be, and Ne", V.G. Kaveeschwar, K. T. Chung; and R.P. Hurst, Phys. Rev. 172, No. 35, pp. 35-44 (1968). Note: the above values should be increased by 5% to obtain approximate experimental values.

Tabulated Data A-10.5. Computed dynamic polarizability for Ne.

frequency (a.u)	Wavelength (Å)	Dynamic Polarizability (a.u.)
0.0	∞	2.3820
0.01	7257	2.3901
0.02	3629	2.4150
0.03	2419	2.4581
0.04	1814	2.5227
0.05	1451	2.6249
0.06	1209	2.7408
0.07	1037	2.9194
0.08	907	3.1815
0.09	806	3.6009
0.10	726	4.4069
0.11	660	6.9338
0.112	648	8.3794
0.114	637	11.2165
0.116	626	19.5271
0.118	615	832.1
0.120	605	-144.5059

From Kaveeschwar, Chung, and Hurst (1968)
NOTE: The above values should be increased by 10% to obtain approximate experimental values.

Tabular Data A-10.6. Dynamic polarizability for the 2^1S state of He for frequencies up to the second excitation energy (in a_o^3).

		Variational Estimates	
$\omega \times 10^2$	Rigorous bounds	Lower	Upper
0.0	316.24 ±0.78	315.61	316.83
0.50	320.63 ±0.79	319.99	321.23
1.00	334.59 ±0.83	333.91	335.21
1.50	360.75 ±0.90	360.10	361.53
2.00	405.65 ±1.03	404.79	406.43
2.50	483.34 ±1.25	482.29	484.29
3.00	632.82 ±1.70	631.39	634.10
3.50	1003.93 ±2.82	1001.53	1006.08
4.00	3199.13 ±10.27	3190.16	3207.18
5.00	-724.20 ±5.89	-729.45	-718.73
6.00	-281.32 ±2.14	-283.14	-279.41
7.00	-157.82 ±1.56	-159.14	-156.44
8.00	-100.11 ±1.55	-101.47	-98.72
9.00	-65.71 ±2.03	-67.54	-63.84
10.00	-39.91 ±3.79	-43.49	-36.31
10.90	-11.93 ±11.88	-23.54	-0.81
11.25	10.98 ±25.63	-14.34	36.19
11.90	1193.00 ±1192	1.86	2377.10

Above from Glover and Weinhold (1977)

Tabular Data A-10.7. Dynamic polarizability for the 2^3S state of He for frequencies up to the second excitation energy (in a_o^3).

		Variational Estimates	
$\omega \times 10^2$	Rigorous bounds	Lower	Upper
0.0	803.31±6.61	800.21	806.67
0.2	809.68±6.68	806.55	813.08
0.4	829.46±6.87	826.20	832.95
0.6	864.74±7.22	861.27	868.41
0.8	919.68±7.77	915.88	923.64
1.0	1011.91±8.60	997.60	1006.29
1.2	1125.63±9.84	1120.56	1130.67
1.4	1319.56±11.81	1313.29	1325.65
1.6	1650.45±15.22	1642.07	1658.34
1.8	2314.75±22.18	2302.02	2326.39
2.0	4246.89±43.32	4220.63	4270.31
2.2	64873.00±1339	63787.22	65895.77
2.5	-2707.52±93.61	-2785.33	-2626.37
3.5	-477.48±13.19	-486.11	-468.03
4.5	-208.08±8.77	-213.65	-201.94
5.5	-106.35±8.39	-111.93	-100.22
6.5	-50.04±10.41	-57.65	-41.82
7.5	-4.78±17.98	-19.64	10.82
8.5	78.79±64.32	18.41	140.00

Above from "Dynamic Polarizabilities of metastable $2^{1,3}S$ excited states of He and Li^+, with rigorous upper and lower bounds" R.M. Glover and F. Weinhold, J. Chem. Phys. 66, No. 1, pp. 185-190 (1977).

Tabular Data A-10.8. Polarizability of atomic ions.

Ion	Dipole Polarizability α ($\mathring{A}^3$)
Li^+	0.0285
Na^+	0.158 *
K^+	0.85 *
Rb^+	1.41 *
Cs^+	2.42 *
He^+	0.0417
Ne^+	0.21
Ar^+	1.07 **
H^+	0
O^+	0.49
He^{++}	0
Ne^{++}	0.15
Ar^{++}	1.04 **
Be^{++}	0.0076
Mg^{++}	0.082
Ca^{++}	0.73
H^-	30.5
O^-	3.2
F^-	1.38 *
Cl^-	3.94 *
Br^-	5.22 *
I^-	7.81 *

Above from the book by McDaniel and Mason (1973) except for *"Empirical Free Ion Polarizabilities of the Alkali Metal, Alkaline Earth Metal, and Halide Ions", H. Coker, J. Phys. Chem. 80, No. 19, p. 2078 (1976) and **"The Static Polarizability of Argon Ions", P. Meier, R. J. Sandeman, and M. Andrews, J. Phys. B 7, No. 11, p. L-339 (1974).

Tabular Data A-10.9.
Polarizabilities for molecules.

Molecule	Mean Dipole Polarizability $\bar{\alpha}(Å^3)$	Anisotropy $\kappa = \frac{\alpha_{\parallel} - \alpha_{\perp}}{\alpha_{\parallel} + 2\alpha_{\perp}}$
H_2	0.808[a]	0.124[a,d]
N_2	1.76[b]	0.176,[b] 0.131[d]
O_2	1.60[b]	0.238,[b] 0.229[d]
Cl_2	4.61[b]	0.215[b]
Br_2	6.46[c]	
CO	1.95[b]	0.167[b]
NO	1.70[c]	
HF	0.79[c]	0.10,[b] 0.093[e]
HCl	2.58[c]	0.094[b]
HBr	3.52[c]	0.084[b]
HI	5.23[c]	0.104[b]
H_2O	1.45[c]	
H_2S	3.67[c]	0.05[b]
CO_2	2.59[c]	0.264[b]
N_2O	2.92[c]	0.310[b]
SO_2	3.78[c]	0.26[b]
NO_2	3.02[c]	
$(NO_2)_2$	6.64[c]	
CH_4	2.56[c]	0
CF_4	2.82[c]	0
CCl_4	10.2[c]	0
SF_6	4.48[c]	0

[a] Victor and Dalgarno (1969).
[b] Hirschfelder, Curtiss, and Bird (1964), p. 950.
[c] Maryott and Buckley (1953).
[d] Langhoff, Gordon, and Karplus (1971)
[e] Muenter (1972).

Tabular Data A-10.10.
Dipole and quadrupole moments.

Molecule	Dipoie Moment $(10^{-18}esu)$[a]	Quadrupole Moment $(10^{-26}esu)$[b]
H_2	0	+0.662
N_2	0	−1.52
O_2	0	−0.39
F_2	0	+0.88
Cl_2	0	+6.14
CO	0.112	−2.5
NO	0.153	−1.8
HF	1.82	+2.6
HCl	1.08	+3.8
HBr	0.82	+4
HI	0.44	+6
H_2O	1.85	$\sim \pm 1$
H_2S	0.97	
CO_2	0	−4.3
N_2O	0.167	−3.0
SO_2	1.63	±4.4
NO_2	0.316	

[a] Nelson, Lide, and Maryott (1967).
[b] Stogryn and Stogryn (1966).

From the book by McDaniel and Mason (1973).

B. HEAVY PARTICLE - HEAVY PARTICLE COLLISIONS

CONTENTS

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B. HEAVY PARTICLE - HEAVY PARTICLE COLLISIONS

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B-1. LOW ENERGY HEAVY PARTICLE - HEAVY PARTICLE COLLISIONS

CONTENTS

Table of Reactions

Reaction rates (k) and cross sections (σ) as a function of collision energy (E), temperature (T), and relative velocity (v).

All the graphs in Section B-1 and the tables on the opposing pages were prepared by the JILA Information Center for inclusion in this volume. We are indebted to Jean Gallagher and John Rumble for their invaluable assistance.

Entries such as "Eqn. 39" (that appears on line 3 of page 229-B-1.3) refer to numbered equations displayed on pages 259 and 260-B-1.28.

Entries such as "Table, Graph 8" (that appears on line 3 of page 227-B-1.1) refer to the table and graph section which begins on page 262-B-1.29 and extends to page 322-B-1.89.

References such as appear in the extreme right-hand column of page 227-B-1.1 are given at the end of Section B-1 immediately after page 323-B-1.89.

Entries that contain the superscript "a" as in 300°K[a], that appears on line 12 of page 227-B-1.1), refer to footnotes that appear on page 253-B-1.27.

Tabular Data B-1.1.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
He + He	→	**Total Scattering**	1700 m/s	35 $Å^2$	87
$He(2^1S)$ + He	→	Quenching	300^oK	3×10^{-4} $Å^2$	16
$He(2^3S_1)$ + He	→	Total Scattering	1000-3500m/s	Table, Graph 8	15
$He(2^3S_1)$ + He	→	$He(2^3S_1)$ + He (elastic)	1000-3500m/s	90% of values in Table, Graph 8	15
$He^3(2^3S_1) + He^3$	→	$He^3 + He^3(2^3S_1)$	$4-500^oK$	Table, Graph 9	13
$He(2^3S)$ + He	→	$He(2^3P)$ + He	8.65eV C.M.	1.42 $Å^2$	14
$He(2^3S)+He(2^3S)$	→	$He^+ + He(1^1S)+e$	300^oK	90 $Å^2$	11
$He(2^3S)+He(2^3S)$	→	$He^+ + He(1^1S) + e$	520^oK	120.0 $Å^2$	12
$He^3(2^3P_0)+He^3$	→	$He^3(2^3P_{1+2})+He^3$	300^oK	68 ± 3 $Å^2$	10
$He(3^1S)$+He	→	$He_2^+ + e$	300^oK	<0.1 $Å^2$	4
$He(3^3S)$+He	→	$He_2^+ + e$	300^oK	<0.01 $Å^2$	4
$He(3^1P)$+He	→	$He(3^1S)$ + He	300^oK^*	$4.5 \pm .03$ $Å^2$	3
$He(3^1P)$+He	→	He + He (3^1P)	300^oK	32.5 ± 1 $Å^2$	2
$He(3^1P)$+He	→	$He(3^1D)$ +He	82^o K	11 ± 2 $Å^2$	1
$He(3^1P)$+He	→	$He(3^1D)$ + He	214^oK	13 ± 8 $Å^2$	1
$He(3^1P)$+He	→	$He(3^1D)$+He	296^oK	16 ± 3 $Å^2$	1
$He(3^1P)$+He	→	$He_2^+ + e$	300^oK	3.1 ± 1 $Å^2$	4
$He(3^3P)$+He	→	$He(3^1S)$+He	300^oK^*	$2.9 \pm .3$ $Å^2$	3

Tabular Data B-1.2.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$He(3^3P)+He$	$\rightarrow$	$He(3^1P) + He$	300^oK	$3 \pm .3Å^2$	2
$He(3^3P)+He$	$\rightarrow$	$He(3^1D) + He$	300^oK^a	$.067 \pm .005Å^2$	3
$He(3^3P)+He$	$\rightarrow$	$He_2^+ + e$	300^oK	$1.6 \pm .1Å^2$	4
$He(3^1D)+He$	$\rightarrow$	$He(3^1S) + He$	300^oK^a	$< .04 Å^2$	3
$He(3^1D)+He$	$\rightarrow$	$He(3^1P) + He$	300^oK	$10.6 \pm .7Å^2$	2
$He(3^1D)+He$	$\rightarrow$	$He(3^3D) + He$	300^oK^a	$<.02Å^2$	3
$He(3^1D)+He$	$\rightarrow$	$He_2^+ + e$	300^oK	$20 \pm 4Å^2$	4
$He(3^3D)+He$	$\rightarrow$	$He(3^1S) + He$	300^oK^a	$<.01Å^2$	3
$He(3^3D)+He$	$\rightarrow$	$He(3^1P) + He$	300^oK	$.62 \pm .05Å^2$	2
$He(3^3D)+He$	$\rightarrow$	$He_2^+ + e$	300^oK	$4.5 \pm .5Å^2$	4
$He(3^3D)+He$	$\rightarrow$	$He_2^+ + e$	450^oK	$26Å^2$	5
$He(4'P)+He$	$\rightarrow$	$He(4^1D) + He$	300^oK^a	$2.8Å^2$	7
$He(4^1P)+He$	$\rightarrow$	$He(4^3D) + He$	300^oK^a	$2.2Å^2$	7
$He(4^1P)+He$	$\rightarrow$	$He(4^3F) + He$	300^oK^a	$.95Å^2$	7
$He(4^3P)+He$	$\rightarrow$	$He(4^3S) + He$	600^oK	$3.5 \pm .3Å^2$	6
$He(4^3P) + He$	$\rightarrow$	$He(4^3D) + He$	600^oK	$9.9 \pm 2.4Å^2$	6
$He(4^3P)+He$	$\rightarrow$	$He(4^1S,{}^1P,{}^1D) + He$	600^oK	$<.2Å^2$	6

Tabular Data B-1.3.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$He^{+} + He$	→	Total Cross Section	4eV Lab. E	38.2 $\AA^2$	28
$He^{+} + He$	→	Total Cross Section	10eV Lab. E	33.7 $\AA^2$	28
$He^{+} + He$	→	$He + He^{+}$	1-90eV Lab. E	Eqn. 39	17
$He^{+}(2S) + He$	→	Total Quenching	0.23eV Lab. E	52.0 $\AA^2$	8
$He^{+}(2S) + He$	→	$He^{+} + He$	$400°K^{a}$	30.3 $\AA^2$	9
$He^{+}(2S) + He$	→	$He^{+} + He^{+} + e$	$400°K^{a}$	14.0 $\AA^2$	9

Tabular Data B-1.4.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
He + Ne	→	Total Cross Section	.8-2.5km/s	Table, Graph 14	27
$He(2^1S)+Ne$	→	$He + Ne(3s)$	$77-400\ ^\circ K$	Eqn. 1	20
$He(2^1S)+Ne$	→	$He + Ne(4s_1)$	300^oK	$1.5\mathring{A}^2$	88
$He(2^1S)+Ne$	→	$He+Ne(4d_4)$	300^oK	$.93\mathring{A}^2$	88
$He(2^1S,2^3S)+Ne(3s\ {}^3P_2,{}^3s\,{}^3P_o)$	→	$HeNe^++e$	.1eV C. M.	$.12^{+60\%}_{-53\%}\ \mathring{A}^2$	19
$He(2^1S) + Ne$	→	$He+Ne^++e$	300^oK	$4.1\mathring{A}^2$	74
$He(^3S_1)+Ne$	→	Total Cross Section	2093m/s	$120\mathring{A}^2$	26
$He(2^3S) + Ne$	→	Quenching	$300\text{-}900^oK$	Table, Graph 6	21
$He(2^3S)+Ne$	→	$He + Ne(2s)$	$77^o\text{-}400^oK$	Eqn. 2	20
$He(2^3S)+Ne$	→	$He+Ne^++e$	300^oK	$.28\mathring{A}^2$	74
$He(3^1P)+Ne$	→	$He(1^1S)+N_e^++e$ $HeNe^++e$	$600^oK\ ^{+200}_{-100}$	$27.6^{+4.5}_{-2.8}\mathring{A}^2$	18
$He(2^3P_o)+Ne$	→	$He+Ne(4s_5)$	300^oK	$0.85\mathring{A}^2$	88
$He(2^3P_o)+Ne$	→	$He+Ne(4d_3)$	300^oK	$0.32\mathring{A}^2$	88
$He(2^3P_o)+Ne$	→	$He+Ne(5d_5)$	300^oK	$1.5\mathring{A}^2$	88
He^++Ne	→	$He+Ne^+$	295^oK	$k\leq 10^{-13}cm^3/s$	22

Tabular Data B-1.5.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
He + Ar	→	Total Cross Section	450-1400m/s	Table, Graph 3	90
He + Ar	→	Elastic Cross Section	800-2500m/s	Table, Graph 13	27
$He(2^1S)+Ar$	→	$HeAr^+ + e$	600^oK	$.9\mathring{A}^2$	29
$He(2^1S)+Ar$	→	$He+Ar^+ + e$	300^oK	$9.0\mathring{A}^2$	75,78,74
$He(2^1S)+Ar$	→	$He+Ar^+ + e$	600^oK	$21.8\mathring{A}^2$	29
$He(2^3S)+Ar$	→	Total Scattering	1000-3500m/s	Table, Graph 15	31
$He(2^3S)+Ar$	→	Quenching	300^oK-900^oK	Table, Graph 5	21
$He(2^3S)+Ar$	→	$HeAr^+ + e$	600^oK	$2.0\mathring{A}^2$	29
$He(2^3S)+Ar$	→	$He+Ar^+ + e$	300^oK	$7.3\pm1.\mathring{A}^2$	74,75,33,79,76,77,78
$He(2^3S)+Ar$	→	$He+Ar^+ + e$	600^oK	$14.9\mathring{A}^2$	29
$He(3^1P)+Ar$	→	$He(1^1S)+Ar^+ + e$ $HeAr^+ + e$	$600^oK^{+200}_{-100}$	$55.6^{+10.6}_{-7.8}\ \mathring{A}^2$	18
$He^+ + Ar$	→	$He+Ar^+$	295^oK	$k<10^{-13}cm^3/sec$	22
$He^+(2s) + Ar$	→	Deexcitation	.23eV Lab. E	$156.0\mathring{A}^2$	8

Tabular Data B-1.6.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
He+Kr	→	Total Cross Section	300-1400m/s	Table, Graph 2	90
He+Kr	→	Total Elastic	800-2500m/s	Table, Graph 12	27
$He(2^1S)+Kr$	→	$He+Kr^++e$	300^oK	$9.0\mathring{A}^2$	32
$He(2^1S)+Kr$	→	Total Ion Production	600^oK	$33.4\mathring{A}^2$	29
$He(2^3S)+Kr$	→	Total (97% Elastic)	1000-3000m/s	Table, Graph 10	31
$He(2^3S)+Kr$	→	$He+Kr^++e$	300^oK	$9.2\mathring{A}^2$	33,76,78,79
$He(2^3S)+Kr$	→	Total Ion Production	600^oK	$19.1\mathring{A}^2$	29
$He(3^1P)+Kr$	→	$He+Kr^++e$ HeKr+e	$600^oK^{+200}_{-100}$	$49.5^{+8.0}_{-4.8}\mathring{A}^2$	18
He^++Kr	→	$He+Kr^+$	300^oK^a	$< 10^{-11}cm^3/s$	122
$He^+(2S) + Kr$	→	Deexcitation	.23eV Lab. E	$199.0\mathring{A}^2$	8
He+Xe	→	Total Scattering	300-1400m/s	Table, Graph 1	90
He+Xe	→	Elastic Scattering	800-2500m/s	Table, Graph 11	27
$He(2^1S)+Xe$	→	Deexcitation	300^oK	$103 \pm {}^{200\%}_{50\%} \mathring{A}^2$	33
$He(2^1S)+Xe$	→	Total Ion Production	600^oK	$34.1\pm15\%\mathring{A}^2$	29

Tabular Data B-1.7.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$He(2^1S)+Xe$	$\rightarrow$	$He+Xe^+ + e$	300^oK	$12\pm3\AA^2$	32
$He(3^1P)+Xe$	$\rightarrow$	$He + Xe^+ + e$ $HeXe^+ + e$	$600^oK\ {}^{+200}_{-100}$	$73.0\ {}^{+12.9}_{-8.8}\AA^2$	18
$He(2^3S)+Xe$	$\rightarrow$	Quenching	300^o-900^oK	Table, Graph 4	21
$He(2^3S)+Xe$	$\rightarrow$	Total Ion Production	600^oK	$20.0\pm15\%\AA^2$	29
$He(2^3S)+Xe$	$\rightarrow$	$He+Xe^+ +e$	300^oK	$12.2\AA^2$	74,76,78,79
$He^+ +Xe$	$\rightarrow$	$He+Xe^+$	300^oK^a	$k = 7 \pm 40\% \times 10^{-12} cm^3/s$	123
$He^+(2s) + Xe$	$\rightarrow$	Deexcitation	.23eV Lab.E	$273.0\AA^2$	8
$Ne(2s_2)+He$	$\rightarrow$	$Ne(2s_3)+He$	350^oK	$1.8\pm.3\AA^2$	25
$Ne(2p_4)+He$	$\rightarrow$	Quenching	300^oK	$7.2\pm3\AA^2$	23
$Ne(3s_2)+He$	$\rightarrow$	Quenching	300^oK	$14.9\pm2\AA^2$	23
$Ne(^3P_o)+He$	$\rightarrow$	$Ne(^3P_{1,2}) + He$	300^oK	$k=8\times10^{-15}cm^3/s$	89
$Ne(^3P_1)+He$	$\rightarrow$	$Ne(^3P_2)+He$	300^oK	$k=1.9\times10^{-14}cm^3/s$	89
$Ne(^3P_2)+He$	$\rightarrow$	Total Cross Section	1605m/s	$123\AA^2$	26
$Ne(^3P_2)+He$	$\rightarrow$	Depolarization	300^oK	$.430\pm0.022\AA^2$	24
$Ne(2s_2)+Ne$	$\rightarrow$ $\rightarrow$	$Ne(2s_3)+Ne$ $Ne+Ne(2s_3)$	350^oK	$2.3\pm.3\AA^2$	25

Tabular Data B-1.8.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$N_e(^3P_{o,2})$+Ne	→	Total Cross Section	300°K	153±10% Å^2	38
$Ne(^3P_o)$+Ne	→	$Ne(^3P_1)$+Ne	300°K	$k=5X10^{-15} cm^3/s$	89
$Ne(^3P_o)$+Ne	→	$Ne(^3P_2)$+Ne	300°K	$k=5x10^{-15} cm^3/s$	89
$Ne(^3P_1)$+Ne	→	$Ne(^3P_2)$+Ne	300°K	$k=4.2x10^{-14} cm^3/s$	89
$Ne(^3P_2)$+Ne	→	Total Cross Section	1173m/s	143Å^2	26
$Ne(^3P_2)$+Ne	→	Depolarization	300°K	16.6±.8Å^2	24
$^{22}Ne^+ + ^{20}Ne$	→	$^{22}Ne + ^{20}Ne^+$	.04-3eV Lab E	Graph 28	39
Ne+Ar	→	Total Cross Section	300°K	154Å^2	40
$Ne(^3P_{o,2})$+Ar	→	Total Cross Section	300°K	278±10% Å^2	38
$Ne(^3P_{o,2})$+Ar	→	$NeAr^+$+e	435°K	4.6±15% Å^2	29
$Ne(^3P_{o,2})$+Ar	→	$Ne+Ar^+$+e	340°K	6.0Å^2	75,80,81,82
$Ne(^3P_{o,2})$+Ar	→	$Ne+Ar^+$+e	435°K	10.1±15% Å^2	29
$Ne(^3P_{o,2})$+Ar	→	Ionization (PI, AI)	.01-500eV C. M.	Table, Graph 22	58
Ratio: 5:1 of $^3P_2:^3P_o$					

Tabular Data B-1.9.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Ne(^3P_2)+Ar$	→	Total Cross Section	1115m/s	$398\mathring{A}^2$	26
Ne^++Ar	→	$Ne+Ar^+$	.1-4eV	Table, Graph 17	41
$Ne(^3P_{0,2})+Kr$	→	$NeKr^++e$	435^oK	$5.3\pm20\%\mathring{A}^2$	29
$Ne(^3P_{0,2})+Kr$	→	$Ne+Kr^++e$	435^oK	$12.3\pm20\%\mathring{A}^2$	29
$Ne^{++}+Kr$	→	Ne^+(Production)	.5-100eV C.M.	Table, Graph 18	42
$Ne^{++}+Kr$	→	Kr^+(Production)	.5-100eV C.M.	Table, Graph 19	42
$Ne^{++}+Kr$	→	Kr^{++}(Production)	.5-100eV C.M.	Table, Graph 24	42
$Ne\ (^3P_{0,2}) + Xe$	→	$NeXe^+ + e$	$435^\circ K$	$3.6\mathring{A}^2$	29
$Ne^+ + Xe$	→	Xe^++He	300^oK^a	$<5x10^{-13}cm^3/s$	123
$Ne\ (^3P_{0,2}) + Xe$	→	$Ne + Xe^+ + e$	$435^\circ K$	$11.3\mathring{A}^2$	29
$Ar(^3P_2)+He$	→	Depolarization	300^oK	$6.2\mathring{A}^2$	24

Tabular Data B-1.10.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Ar(^3P_2)+Ne$	$\rightarrow$	Depolarization	300^oK	$26\pm2Å^2$	24
Ar+Ar	$\rightarrow$	Elastic Cross Section	150-4000m/s	Table,Graph 7	48
Ar+Ar	$\rightarrow$	Ar^*+Ar	7000^oK	$k=2.99x10^{-22}cm^3/s$	46
			8000^oK	$k=3240.0x10^{-22}cm^3/s$	
			9000^oK	$k=208.0x10^{-22}cm^3/s$	
			10000^oK	$k=940.0x10^{-22}cm^3/s$	
			11000^oK	$k= 32.40x10^{-22}cm^3/s$	
			12000^oK	$k=9470.0x10^{-22}cm^3/s$	
$Ar(1s_3)+Ar$	$\rightarrow$	Deexcitation	300^oK	$k=10\pm1.3x10^{-20}cm^3/s$	44
$Ar(1s_5)+Ar$	$\rightarrow$	Deexcitation	300^oK	$k=1.8\pm0.5x10^{-20}cm^3/s$	45
$Ar(^3P_2)+Ar$	$\rightarrow$	Depolarization	300^oK	$100\pm7Å^2$	24
Ar^*+Ar	$\rightarrow$	Ar_2^++e	340^oK	$k=1.7X10^{-9}cm^3/s$	83
Ar^*+Ar	$\rightarrow$	$Ar_2^+ +e$	500^oK	$k=.32X10^{-9}cm^3/s$	83
Ar^*+Ar^*	$\rightarrow$	Ar^++Ar+e	300^oK^a	$k=5x10^{-10}cm^3/s$	43

Tabular Data B-1.11.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
Ar^*+Ar	→	Ar^++e+Ar	7000^oK	$k=4.0x10^{-14}cm^3/s$	46
			8000^oK	$k=11.0x10^{-14}cm^3/s$	
			9000^oK	$k=23.6x10^{-14}cm^3/s$	
			10000^oK	$k=43.5x10^{-14}cm^3/s$	
			11000^oK	$k=70.6x10^{-14}cm^3/s$	
			12000^oK	$k=110.0x10^{-14}cm^3/s$	
Ar^++Ar	→	$Ar+Ar^+$	.1-5eV Lab. E	Table, Graph 16	84
Ar^++Ar	→	$Ar+Ar^+$	1-50eV Lab. E	Eqn. 40	17
$Ar^+(^2P_{\frac{1}{2}})+Ar$	→	$Ar^+(^2P_{\frac{3}{2}})+Ar$	296^oK	$k=2x10^{-16}cm^3/s$	47
$Ar(^3P_{2,0})$ + Kr Ratio 5:1 of $^3P_2$:$^3P_0$	→	Elastic Cross Section	60.6meV C.M.	$792\pm270Å^2$	49
			70.9meV C.M.	$792\pm290Å^2$	
			110.0meV C.M.	$532\pm260Å^2$	
			156.0meV C.M.	$435\pm160Å^2$	
$Ar(^3P_0)+Kr$	→	$Kr(5p[\frac{1}{2}]_0)+Ar$	300^oK	$k=3.4x10^{-15}cm^3/s$	50
$Ar(^3P_0)+Kr$	→	Products	300^oK	$k=2.3x10^{-12}cm^3/s$	50
$Ar(^3P_2)+Kr$	→	$Kr(5P[\frac{3}{2}]_1)+Ar$	300^oK	$k=0.65x10^{-12}cm^3/s$	50
$Ar(^3P_2)+Kr$	→	$Kr(5P[\frac{3}{2}]_2)+Ar$	300^oK	$k=5.5x10^{-12}cm^3/s$	50

Tabular Data B-1.12.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
Ar^*+Kr	$\rightarrow$	$Ar+Kr^*$	40-200meV C.M.	Table, Graph 23	49
$Ar+Xe$	$\rightarrow$	Total	300^0K	$685Å^2$	53
$Ar(^3P_2)+Xe$	$\rightarrow$	Depolarization	300^0K	$127Å^2$	24
Ar^*+Xe	$\rightarrow$	$Ar+Xe^*$	300^0K	$2300Å^2$	51
$Kr^{++}+Ne$	$\rightarrow$	Ne^+(Production)	.23-14eV C.M.	Table, Graph 26	42
$Kr^{++}+Ne$	$\rightarrow$	Kr^+(Production)	.5-15eV C.M.	Table, Graph 25	42
$Kr(5P[\frac{3}{2}]_1)+Ar$	$\rightarrow$	$Kr(5P[\frac{3}{2}]_2)+Ar$	300^0K	$k=0.39x10^{-11}cm^3/s$	50

Tabular Data B-1.13.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Kr(5p[\frac{3}{2}]_1)+Ar$	→	$Kr(5p[\frac{5}{2}]_2)+Ar$	300^oK	$k=2.5\times10^{-11}cm^3/s$	50
$Kr(5p[\frac{3}{2}]_1)+Ar$	→	$Kr(5p[\frac{5}{2}]_3)+Ar$	300^oK	$k=4.2\times10^{-11}cm^3/s$	50
$Kr(5p[\frac{3}{2}]_2)+Ar$	→	$Kr(5p[\frac{3}{2}]_1)+Ar$	300^oK	$k=1.4\times10^{-11}cm^3/s$	50
$Kr(1s_3)+Kr$	→	Kr+Kr	300^oK	$k=9.0\times10^{-15}cm^3/s$	56
$Kr(1s_5)+Kr$	→	Kr+Kr	300^oK	$k=2.2\times10^{-15}cm^3/s$	55
$Kr(^1D_2')+Kr$	→	Depolarization	292^oK	$449\AA^2$	54
$Kr(^3D_3)+Kr$	→	Depolarization	292^oK	$479\AA^2$	54
Kr^++Kr	→	$Kr+Kr^+$	.04-3eV C.M.	$100\pm15\AA^2$	57
$Kr(5s[\frac{3}{2}]_2)+Xe$	→	Quenching	500^oK	$100\AA^2$	59
$Kr(5s[\frac{3}{2}]_2)+Xe$	→	$Kr+Xe(6p[\frac{1}{2}]_0)$	500^oK	$37\AA^2$	59
$Kr(5s[\frac{3}{2}]_2)+Xe$	→	$Kr+Xe(6p[\frac{3}{2}]_1)$	300^oK	$10\pm4\AA^2$	59

Tabular Data B-1.14.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Xe(^3P_2)+He$	$\rightarrow$	Depolarization	300^oK	$15\pm1Å^2$	24
$Xe(^3P_2)+Ne$	$\rightarrow$	Depolarization	300^oK	$38\pm2Å^2$	24
$Xe(^3P_1)+Ar$	$\rightarrow$	$Xe(^3P_2)+Ar$	300^oK^a	$k=1.5\pm.3x10^{-14}cm^3/s$	52
$Xe(^3P_2)+Ar$	$\rightarrow$	Xe+Ar	300^oK^a	$k=3.2\pm0.7x10^{-16}cm^3/s$	52
$Xe(^3P_2)+Ar$	$\rightarrow$	$Xe(^3P_1)+Ar$	300^oK^a	$k=8.3\pm1.5x10^{-17}cm^3/s$	52
$Xe(^3P_2)+Ar$	$\rightarrow$	Depolarization	300^oK	$61\pm4Å^2$	24

Tabular Data B-1.15.

Reaction	Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Xe^{*}+Xe \rightarrow Xe_2^{+}+e$	4000^{o}-$9000^{o}K$	Eqn.3	60
$Xe(^3P_2) + Xe \rightarrow$ Depolarization	$300^{o}K$	$190 \pm 16Å^2$	24
$Xe^{+}+Xe \rightarrow Xe+Xe^{+}$	1-70eV Lab E	Table, Graph 21	61
$Xe^{*}+Xe^{*} \rightarrow Xe^{+}+Xe+e$	$300^{o}K^{a}$	$k= 5x10^{-10}\ cm^3/s$	86
$Xe^{**}+Xe^{**} \rightarrow Xe^{+}+Xe+e$	$300^{o}K^{a}$	$k= 5x10^{-10}\ cm^3/s$	86
$Xe^{+}+He_2^{*} \rightarrow 2He+Xe^{+*}$	600m/s Xe vel	$400Å^2$	36
$He_2(3p\ ^3\Pi_g,J=8)+He \rightarrow He_2(3p\ ^3\Pi_g,J=7)+He$	$300^{o}K^{a}$	$k=2.4X10^{-11}cm^3/s$	68
$He_2^{+}+Ne \rightarrow Ne^{+}+2He$	$200^{o}K$	$k=5.x10^{-10}cm^3/s$	34
$He_2^{+}+Ar \rightarrow Ar^{+}+2He$	$200^{o}K$	$k=2.2x10^{-10}cm^3/s$	34

Tabular Data B-1.16.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$He_2^+ + Kr$	$\rightarrow$	$Kr^+ + 2He$	200^0K	$k=1.85x10^{-11}cm^3/s$	35
$Ne_2^+ + Ar$	$\rightarrow$	$Ar^+ + 2Ne$	200^0K	$k\leq 5x10^{-14}cm^3/s$	35
$Ne_2^+ + Kr$	$\rightarrow$	$Kr^+ + 2Ne$	300^0K	$k\leq 1x10^{-13}cm^3/s$	117
$Ne_2^+ + Xe$	$\rightarrow$	$Xe^+ + 2Ne$	300^0K	$k\leq 10^{-13}cm^3/s$	117
$Ar_2^* + Kr$	$\rightarrow$	$Kr^* + 2Ar$	300^0K	$k=8.0\pm .2x10^{-11}cm^3/s$	85
$Ar_2^+ + Kr$	$\rightarrow$	$Kr^+ + 2Ar$	300^0K	$k=6x10^{-10}cm^3/s$	117
$Ar_2^+ + Kr$	$\rightarrow$	$Kr^+ + 2Ar$	200^0K	$k=7.5x10^{-10}cm^3/s$	35
$Ar_2^*(^1\Sigma_u) + Xe$	$\rightarrow$	$Xe(^1P_1)$Production	300^0K	$k=4.39\pm 0.05x10^{-10}cm^3/s$	52
$Ar_2^*(^3\Sigma_u) + Xe$	$\rightarrow$	$Xe(^1P_1)$Production	300^0K	$780Å^{2b}$	63
$Kr_2^{+*} + Kr$	$\rightarrow$	Vibrational Relaxation	300^0K	$0.014\pm 0.0007Å^2$	65
$Kr_2^*(^1\Sigma_u) + Xe$	$\rightarrow$	$Xe(^3P_1)$Production	300^0K	$780Å^{2b}$	63
$Kr_2^*(^3\Sigma_u) + Xe$	$\rightarrow$	$Xe(^3P_1)$Production	300^0K	$100Å^{2b}$	63
$Kr_2^+ + Xe$	$\rightarrow$	$KrXe^+ + Kr$	300^0K^a	$k\approx 10^{-10}cm^3/s$	64
$Xe_2^* + Xe$	$\rightarrow$	Quenching	300^0K	$0.033\pm 0.013Å^2$	62
$Xe_2^{**} + Xe$	$\rightarrow$	$Xe^* + 2Xe$	300^0K^a	$10^{-11}cm^3/s$	86

Tabular Data B-1.17.

Reaction	Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Ar_2^* + Ar_2^* \rightarrow Ar_2^+ + 2Ar + e$	300^0K	$k = 5\times10^{-10} cm^3/s$	43
$Xe_2^* + Xe_2^* \rightarrow Xe_2^+ + 2Xe + e$ $Xe^+ + 3Xe + e$	300^0K	$k = 3.5 \pm 1.4\times10^{-10} cm^3/s$	62
$Xe_2^{**} + Xe_2^{**} \rightarrow Xe_2^+ + 2Xe + e$	300^0K^a	$5\times10^{-10} cm^3/s$	86
$HeNe^+ + Ne \rightarrow Ne_2^+ + He$	200^0K	$k = 1.4\times10^{-10} cm^3/s$	35
$HeNe^+ + Ne \rightarrow Ne_2^+ + He$	300^0K	$k = 3\times10^{-11} cm^3/s$	37
$HeAr^+ + Ar \rightarrow Ar^+ + He + Ar$	330^0K	$310 \pm 20 Å^2$	124
$HeAr^+ + Ar \rightarrow Ar_2^+ + He$	330^0K	$33 \pm 6 Å^2$	124
$HeKr^+ + Kr \rightarrow Kr^+ + Kr + He$	330^0K	$470 \pm 30 Å^2$	124
$HeKr^+ + Kr \rightarrow Kr_2^+ + He$	330^0K	$15 \pm 3 Å^2$	124
$NeAr^+ + Ar \rightarrow Ar^+ + Ne + Ar$	330^0K	$210 \pm 15 Å^2$	124
$NeAr^+ + Ar \rightarrow Ar_2^+ + Ne$	330^0K	$23 \pm 5 Å^2$	124
$NeKr^+ + Kr \rightarrow Kr^+ + Kr + Ne$	330^0K	$310 \pm 20 Å^2$	124
$NeKr^+ + Kr \rightarrow Kr_2^+ + Ne$	330^0K	$11 \pm 3 Å^2$	124

Tabular Data B-1.18.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$ArKr^*+Ar$	→	$Kr^*(5p[\frac{1}{2}]_0)+2Ar$	300^0K	$k=1.0x10^{-18}cm^3/s$	50
$ArKr^*+Kr$	→	Kr_2^*+Ar	300^0K	$k=1\pm1x10^{-10}cm^3/s$	85
$ArKr^++Kr$	→	Kr_2^++Ar	200^0K	$k=3.2x10^{-10}cm^3/s$	35
$KrXe^++Xe$	→	Xe_2^++Kr	300^0K^a	$k\sim10^{-10}cm^3/s$	64

Tabular Data B-1.19.

Reaction	Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$He(^3S_1)+2He \rightarrow He_2(^3\Sigma_u)+He$	279^oK	$k=2.2x10^{-34}cm^6/s$	67
$He(^3S_1)+2He \rightarrow He_2(^3\Sigma_u)+He$	366^oK	$k=4.27x10^{-34}cm^6/s$	67
$He^+ +2He \rightarrow He_2^+ +He$	300^oK	$k=10.8x10^{-32}cm^6/s$	66
$Ne^+ +2He \rightarrow (HeNe)^+ +He$	300^oK	$k=2.1x10^{-32}cm^6/s$	37
$Ne^+ +Ne+He \rightarrow Ne_2^+ +He$ $(HeNe)^+ +Ne$	300^oK	$k=3.0x10^{-31}cm^6/s$	37
$Ne^+ +2Ne \rightarrow Ne_2^+ +Ne$	300^oK	$k=4.4\pm0.4x10^{-32}cm^6/s$	70
$Ar^+ +Ar+He \rightarrow Ar_2^* + He$	80^oK	$k=1.6x10^{-30}cm^6/s$	71
$Ar^+ +Ar+He \rightarrow Ar_2^+ +He$	300^oK	$k=1.3x10^{-31}cm^6/s$	71
$Ar^+ +Ar+He \rightarrow ArHe^+ +Ar$	300^oK	$k=7.5x10^{-32}cm^6/s$	66
$Ar^+ +Ar+Ne \rightarrow (ArNe)^+ +Ar$	300^oK	$k=25x10^{-32}cm^6/s$	66
$Ar^* +2Ar \rightarrow Ar_2^* +Ar$	300^oK	$k=3x10^{-33}cm^6/s$	43
$Ar^+(^2P_{\frac{3}{2}})+2Ar \rightarrow Ar_2^+ +Ar$	195^oK	$k=3.0\pm.2x10^{-31}cm^6/s$	47
$Ar^+(^2P_{\frac{3}{2}})+2Ar \rightarrow Ar_2^+ +Ar$	296^oK	$k=2.3x10^{-31}cm^6/s$	47

Tabular Data B-1.20.

Reaction	Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Ar^{+}+2Ar \rightarrow Ar_2^{+}+Ar$	$300^{o}K$	$k=2.5x10^{-31}cm^6/s$	43
$Ar^{*}(^3P_o)+Kr+Ar \rightarrow ArKr^{*}+Ar$	$300^{o}K$	$k=2.5x10^{-30}cm^6/s$	50
$Kr^{*}+2Ar \rightarrow ArKr^{*}+Ar$	$300^{o}K^{a}$	$k=1\pm1x10^{-32}cm^6/s$	85
$Kr(1s_3)+2Kr \rightarrow Kr_2^{*}+Kr$	$300^{o}K$	$k=53.6x10^{-33}cm^6/s$	56
$Kr(1s_5)+2Kr \rightarrow$ Destruction	$300^{o}K$	$k=38x10^{-33}cm^6/s$	55
$Kr^{+}+Kr+Kr \rightarrow Kr_2^{+}+Kr$	$300^{o}K$	$k=2.4\pm.13x10^{-31}cm^6/s$	73
$Xe^{*}+Xe+He \rightarrow Xe_2^{*}+He$	$300^{o}K^{a}$	$k=1.4\pm0.3x10^{-32}cm^6/s$	72
$Xe^{*}(^3P_1)+Xe+Ar \rightarrow Xe_2^{*}(Ou:High\ v) + Ar$	$300^{o}K^{a}$	$k=2.1\pm.2x10^{-31}cm^6/s$	52
$Xe^{*}(^3P_2)+Xe+Ar \rightarrow Xe_2^{*}(1_u)+Ar$	$300^{o}K^{a}$	$k=2.15\pm0.25x10^{-32}cm^6/s$	52
$Xe^{*}(^3P_{1,2})+2Xe \rightarrow Xe_2^{*}(^{1,3}\Sigma_u^{+})+Xe$	$300^{o}K^{a}$	$k=5.0\pm1.4x10^{-32}cm^6/s$	72
$Xe^{+}+2Xe \rightarrow Xe_2^{+}+Xe$	$300^{o}K^{a}$	$2.5x10^{-31}cm^6/s$	86
$Xe^{**}+2Xe \rightarrow Xe_2^{**}+Xe$	$300^{o}K^{a}$	$10^{-31}cm^6/s$	86
$He_2^{+}+He+Ne \rightarrow Ne^{+}+3He$	$300^{o}K$	$k=2\pm2x10^{-30}cm^6/s$	69
$He_2^{+}+He+Ar \rightarrow Ar^{+}+3He$	$300^{o}K$	$k=24\pm6x10^{-30}cm^6/s$	69
$Ar_2^{+}+Ar+He \rightarrow Ar_3^{+}+He$	$80^{o}K$	$k=5.5x10^{-31}cm^6/s$	71

Tabular Data B-1.21.

Reaction			Temperature Velocity, or Energy	Cross Section or Reaction Rate	Reference
$Ne+Cl^-$	→	$Cl+Ne+e$	7-15eV C.M.	Graph 27	91
$Ar+F^-$	→	$F+Ar+e$	$4000\text{-}6200^oK$	Eqn. 4	92
$Ar+Cl^-$	→	$Ar+Cl+e$	$3500^o - 5000^oK$	Eqn. 5	93
$Ar+Br^-$	→	$Ar+Br+e$	$3500^o - 5000^oK$	Eqn. 6	93
$Ar+I^-$	→	$Ar+I+e$	$3500^o - 5000^oK$	Eqn. 7	93
$He+Cl_2$	→	$2Cl+He$	$1700\text{-}2800^oK$	Eqn. 8	94
$He+I_2^*$	→	**Quenching**	293^oK	$1.34Å^2$	118
$Ne+F_2$	→	$F+F+Ne$	$1422\text{-}2670^oK$	Table 29	95
$Ne+I_2^*$	→	**Quenching**	293^oK	$5.22Å^2$	118
$Ar+F_2$	→	$F+F+Ar$	$1130\text{-}2617^oK$	Table, Graph 20	95
$Ar+Cl_2$	→	$2Cl+Ar$	$1700\text{-}2800^oK$	Eqn. 9	94
$Ar(^3P_o)+Cl_2$	→	$Ar+Cl+Cl(^2P_{\frac{1}{2}})$	300^oK	$k=1.2x10^{-11}cm^3/s$	96
$Ar(^3P_o)+Cl_2$	→	$Ar+Cl+Cl(^2P_{\frac{3}{2}})$	300^oK	$k=8.0x10^{-11}cm^3/s$	96
$Ar(^3P_{o,2})+Cl_2$	→	$Ar+Cl+Cl(^4P_{\frac{1}{2}})$	300^oK	$k=4.4x10^{-12}cm^3/s$	96

Tabular Data B-1.22.

Reaction			Temperature, Velocity, or Energy	Cross Section or Reaction Rate	Reference
$Ar(^3P_{0,2})+Cl_2$	$\rightarrow$	$Ar+Cl+Cl(^4P_{\frac{3}{2}})$	300^0K	$k=7.88x10^{-11}cm^3/s$	96
$Ar(^3P_2)+Cl_2$	$\rightarrow$	Quenching	300^0K	$k=71\pm14x10^{-11}cm^3/s$	96
$Ar(^3P_2)+Cl_2$	$\rightarrow$	$ArCl^*+Cl$	300^0K	$k=21x10^{-11}cm^3/s$	96
$Ar(^3P_2)+Cl_2$	$\rightarrow$	$Ar+Cl_2^*$	300^0K	$k=1.8x10^{-11}cm^3/s$	96
$Ar(^3P_2)+Cl_2$	$\rightarrow$	$Ar+Cl+Cl(^4P_{\frac{5}{2}})$	300^0K	$k=2.70x10^{-11}cm^3/s$	96
$Ar(^3P_2)+Cl_2$	$\rightarrow$	$Ar+Cl_2^++e$	300^0K	$k\leq 22x10^{-11}cm^3/s$	96
$Ar+Br_2$	$\rightarrow$	$Br+Br+Ar$	1310^0-2225^0K	Table 34	97
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	Total Quenching	300^0K	$k=66.0x10^{-11}cm^3/s$	96
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$ArBr^*+Br$	300^0K	$k=.52x10^{-11}cm^3/s$	96
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$Ar+Br+Br(5s'' \ ^2S_{\frac{1}{2}})$	300^0K	$k=6.0x10^{-11}cm^3/s$	96
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$Ar+Br+Br(5s \ ^2P_{\frac{1}{2}})$	300^0K	$k=3.1x10^{-11}cm^3/s$	96
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$Ar+Br+Br(5s \ ^2P_{\frac{2}{3}})$	300^0K	$k=5.2x10^{-11}cm^3/s$	96
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$Ar+Br+Br(5s \ ^4P_{\frac{1}{2}})$	300^0K	$k=3.0X10^{-11}cm^3/s$	96
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$Ar+Br+Br(5s \ ^4P_{\frac{3}{2}})$	300^0K	$k=26.4x10^{-11}cm^3/s$	96

Tabular Data B-1.23.

Reaction			Temperature, Velocity or Energy	Cross Section or Reaction Rate	Reference
$Ar(^3P_{2,o})+Br_2$	$\rightarrow$	$Ar+Br+Br(5s\ ^4P_{\frac{5}{2}})$	300^oK	$k=21.1\times10^{-11}cm^3/s$	96
$Ar+I_2^*$	$\rightarrow$	Quenching	293^oK	$5.11Å^2$	118
$Kr+I_2^*$	$\rightarrow$	Quenching	293^oK	$7.44Å^2$	118
$Xe+I_2^*$	$\rightarrow$	Quenching	293^oK	$10.62Å^2$	118
$He^+(2s)+CCl_4$	$\rightarrow$	Deexcitation	.23eV Lab. E	$420.0Å^2$	8
$Ar+CF_2$	$\rightarrow$	$CF+F+Ar$	$2600\text{-}3700^oK$	Eqn. 10	98
$Ar+CF_3$	$\rightarrow$	CF_2+F+Ar	$1700\text{-}3000^oK$	Eqn. 11	98
$Ar+CF_4$	$\rightarrow$	CF_3+F+Ar	$1700\text{-}3000^oK$	Eqn. 12	98
$Ar+C_2F_6$	$\rightarrow$	CF_3+CF_3+Ar	$1700\text{-}3000^oK$	Eqn. 13	98
$Ar(^3P_2)+CCl_4$	$\rightarrow$	Quenching	300^oK	$k=10\times10^{-10}cm^3/s$	99
$Ar+CF_3I$	$\rightarrow$	CF_3+I+Ar	$1700\text{-}3000^oK$	Eqn. 14	98

Tabular Data B-1.24.

Reaction			Temperature, Velocity, or Energy	Cross Section or Reaction Rate	Reference
$He+Cl+Cl$	$\rightarrow$	Cl_2+He	313^oK	$k=4.18x10^{-33}cm^6/s$	100
$He+Br+Br$	$\rightarrow$	Br_2+He	$300-1275^oK$	Eqn. 15	101
$He+I+I$	$\rightarrow$	I_2+He	$206-1173^oK$	Eqn. 16	102
$He+I+I$	$\rightarrow$	I_2+He	1400^oK	$k=4.95 \times 10^{-34} cm^6/s$	103
$Ne+Br+Br$	$\rightarrow$	Br_2+Ne	$300-1275^oK$	Eqn. 17	101
$Ne+I+I$	$\rightarrow$	I_2+Ne	293^oK	$k=.92x10^{-32}cm^6/s$	104
$Ar+F+F$	$\rightarrow$	F_2+Ar	1650^o-2700^oK	Eqn. 18	98
$Ar+Cl+Cl$	$\rightarrow$	Cl_2+Ar	1738^o-2475^oK	Table 31	95
$Ar+Br+Br$	$\rightarrow$	Br_2+Ar	$300-1275^oK$	Eqn. 19	101
$Ar+Br+Br$	$\rightarrow$	Br_2+Ar	$1600-3000^oK$	Eqn. 20	106
$Ar+Br_2+Br^-$	$\rightarrow$	Br_3^-+Ar	300^oK	$k=1.9x10^{-28}cm^6/s$	107
$Ar+I+I$	$\rightarrow$	I_2+Ar	$206-1173^oK$	Eqn. 21	102
$Kr+Br+Br$	$\rightarrow$	Br_2+Kr	$300-1275^oK$	Eqn. 22	101
$Kr+I+I$	$\rightarrow$	I_2+Kr	293^oK	$k=2.25x10^{-32}cm^6/s$	104
$Xe+Br+Br$	$\rightarrow$	Br_2+Xe	$300-1273^oK$	Eqn. 23	108
$Xe+I+I$	$\rightarrow$	I_2+Xe	$206-1173^oK$	Eqn. 24	102
$Ar+F+CF$	$\rightarrow$	CF_2+Ar	$2600-3700^oK$	Eqn. 25	98
$Ar+F+CF_2$	$\rightarrow$	CF_3+Ar	$1700-3000^oK$	Eqn. 26	98

Tabular Data B-1.25.

Reaction	Temperature, Velocity, or Energy	Cross Section or Reaction Rate	Reference
$Ar+F+CF_3 \rightarrow CF_4+Ar$	1700-3000^oK	Eqn. 27	98
$Ar+CF_3+CF_3 \rightarrow C_2F_6+Ar$	1700-3000^oK	Eqn. 28	98
$(noble)^+ + F^- + (noble) \rightarrow (noble)F^* + (noble)$	**300°K**	**Table, Graph 35**	**125**
$(noble)_2^+ + F^- + (noble) \rightarrow [(noble)_2F]^* + (noble)$	300°K	Table, Graph 36	126
$Cl+Br_2 \rightarrow BrCl+Br$	298^oK	$k=1.20\pm0.15\times10^{-10}cm^3/s$	109
$Cl+BrCl \rightarrow Cl_2+Br$	298^oK	$k=1.45\pm0.20\times10^{-11}cm^3/s$	109
$Cl+ICl \rightarrow Cl_2+I$	298^oK	$k=8.0\pm1.0\times10^{-12}cm^3/s$	109
$Br+F_2 \rightarrow BrF+F$	296^o-418^oK.	Eqn. 29	110
$Br+ICl \rightarrow BrCl+I$	298^oK	$k=3.0\pm0.8\times10^{-14}cm^3/s$	109
$Br+IBr \rightarrow Br_2+I$	298^oK	$k=3.5\pm0.6\times10^{-11}cm^3/s$	109
$I(5P^5\ ^2P_{\frac{1}{2}})+I_2 \rightarrow I+I_2$	300^oK	$k=3.6\pm0.3\times10^{-11}cm^3/s$	119
$I(^2P_{\frac{3}{2}})+I_2(B^3\Pi_{ou+}, v'=25) \rightarrow [I^*I] \rightarrow I_2+I$	880^oK	$120\pm45Å^2$	111
$F+CF_3 \rightarrow CF_2+F_2$	Roughly 2000^oK	Eqn. 30	98
$F+CF_4 \rightarrow CF_3+F_2$	Roughly 2000^oK	Eqn. 31	98

Tabular Data B-1.26.

Reaction			Temperature, Velocity, or Energy	Cross Section or Reaction Rate	Reference
F_2+Cl_2	→	$2ClF$	$350-400^oK$	Eqn. 32	112
Cl_2+Cl_2	→	$2Cl+Cl_2$	$1700-2800^oK$	Eqn. 38	94
$Cl_2^-+{}^*Cl_2$	→	${}^*Cl_2^-+Cl_2$	0.3eV Lab. E	$k=1.5x10^{-10}cm^3/S$	113
$Cl_2^-+{}^*Cl_2$	→	Cl_3^-+Cl	0.3eV Lab. E	$k=8.4x10^{-13}cm^3/s$	113
$Cl_2^-+Br_2$	→	$Br_2^-+Cl_2$	0.3eV Lab. E	$k=1.8x10^{-10}cm^3/s$	113
$Cl_2^-+Br_2$	→	Br_2Cl^-+Cl	0.3eV Lab. E	$k=3.8x10^{-11}cm^3/s$	113
$Cl_2^-+Br_2$	→	$BrCl^-+(?)$	0.3eV Lab. E	$k=1.6x10^{-11}cm^3/s$	113
$Cl_2^-+Br_2$	→	$BrCl_2^-+Br$	0.3eV Lab. E	$k=1.0x10^{-11}\ cm^3/s$	113
$Cl_2^-+I_2$	→	$I_2^-+Cl_2$	0.3eV Lab. E	$k=7.7x10^{-11}cm^3/s$	113
$Cl_2^-+I_2$	→	ICl_2^-+I	0.3eV Lab. E	$k=3.0x10^{-11}cm^3/s$	113
$Cl_2^-+I_2$	→	$ICl^-+(?)$	0.3eV Lab. E	$k=3.0x10^{-11}cm^3/s$	113
$Cl_2^-+I_2$	→	I_2Cl^-+Cl	0.3eV Lab. E	$k=5.5x10^{-11}cm^3/s$	113
Br_2+Br_2	→	$2Br+Br_2$	$1010^oK-1610^oK$	Table 33	97
$Br_2(B\ {}^3\Pi_{ou}{}^+)+Br_2$	→	Quenching	300^oK^a	Table 32	121
$I_2^-+Cl_2$	→	$Cl_2^-+I_2$	0.3eV Lab. E	$k=2.0x10^{-11}cm^3/s$	113
$I_2^-+Cl_2$	→	ClI_2^-+Cl	0.3eV Lab. E	$k=3.0x10^{-11}cm^3/s$	113
$I_2^-+Cl_2$	→	$ClI^-+(?)$	0.3eV Lab. E	$k=2.4x10^{-11}cm^3/s$	113

Tabular Data B-1.27.

Reaction			Temperature, Velocity, or Energy	Cross Section or Reaction Rate	Reference
$I_2^- + Cl_2$	→	$Cl_2I^- + I$	0.3eV Lab E.	$k=2.8 \times 10^{-11} cm^3/s$	113
$I_2^* + I_2$	→	**Quenching**	293^oK	$65.6 \AA^2$	118
$I_2^- + I_2$	→	$I_3^- + I$	0.3eV Lab. E	$k=1.1 \times 10^{-10} cm^3/s$	113
$F_2 + CF_2$	→	$CF_3 + F$	Roughly 2000^oK	Eqn. 33	98
$F_2 + CF_3$	→	$CF_4 + F$	Roughly 2000^oK	Eqn. 34	98
$Br + Br + Br$	→	$Br_2 + Br$	300^o-2985^oK	Eqn. 35	101
$Cl + Cl + Cl_2$	→	$2Cl_2$	195-490^oK	Table 30	95
$Br + Br + Br_2$	→	$Br_2 + Br_2$	300^o-3000^oK	Eqn. 36	115
$I + I + I_2$	→	$I_2 + I_2$	300-1173^oK	Eqn. 37	102
$Br^- + Br_2 + Br_2$	→	$Br_3^- + Br_2$	296^oK	$k=2.9 \times 10^{-29} cm^6/s$	116

FOOTNOTES

a. These temperatures are in doubt since they were not found in the reference.

b. These values may be high. See J. Chem. Physics 66 1590 (1977).

Tabular Data B-1.27a.

Reaction	Temperature	Reaction Rate (cm^3/s)	Reference
$Xe^* + F_2 \rightarrow XeF^* + F$	300^oK	7.5×10^{-10}	127
$Xe^* + OF_2 \rightarrow XeF^* + (?)$	300^oK	5.7×10^{-10}	127
$Xe^* + NF_3 \rightarrow XeF^* + (?)$	300^oK	9×10^{-11}	127
$Xe^* + NOF \rightarrow XeF^* + (?)$	300^oK	3.9×10^{-10}	127
$Xe^* + Cl_2 \rightarrow XeCl^* + Cl$	300^oK	7.2×10^{-10}	127
$Xe^* + HCl \rightarrow XeCl^* + H$	300^oK	5.6×10^{-10}	127
$Xe^* + Br_2 \rightarrow XeBr^* + Br$	300^oK	6.0×10^{-10}	127
$Kr^* + F_2 \rightarrow KrF^* + F$	300^oK	7.2×10^{-10}	127
	300^oK	5.2×10^{-10}	128
$Kr^* + OF_2 \rightarrow KrF^* + (?)$	300^oK	5.3×10^{-10}	127
$Kr^* + NF_3 \rightarrow KrF^* + (?)$	300^oK	8.9×10^{-11}	127
$Kr^* + NOF \rightarrow KrF^* + (?)$	300^oK	4.7×10^{-10}	127
$Kr^* + Cl_2 \rightarrow KrCl^* + Cl$	300^oK	7.3×10^{-10}	127
$Ar^* + F_2 \rightarrow ArF^* + F$	300^oK	7.5×10^{-10}	127

The following reactions were added in proof. We wish to thank Dr. C. A. Brau for permission to use these data which will appear in the chapter entitled "Rare Gas Halide Lasers" in the forthcoming book Excimer Lasers, C. K. Rhodes (Ed.) Springer-Verlag, (Berlin, 1978).

Tabular Data B-1.27b.

Reaction	Temperature	Reaction Rate (cm^3/s)	Reference
	300°K	9×10^{-10}	127
$Ar^* + Cl_2 \rightarrow ArCl^* + Cl$	300°K	7.1×10^{-10}	127
$Ar_2^* + F_2 \rightarrow ArF^* + Ar + F$	300°K	3×10^{-10}	129
	300°K	5.1×10^{-10}	128
$Kr_2^* + F_2 \rightarrow KrF^* + Kr + F$	300°K	4.2×10^{-10}	130
	300°K	4.0×10^{-10}	128
$Kr_2^+ + Xe \rightarrow Xe^+ + 2\,Kr$	300°K	2×10^{-10}	131
		Reaction Rate (cm^6/s)	
$Xe^* + 2Ar \rightarrow (ArXe)^* + Ar$	300°K	1×10^{-33}	132
	300°K	7×10^{-34}	133
$Kr^+ + Kr + He \rightarrow Kr_2 + He$	300°K	6.1×10^{-32}	134
$Xe^+ + Xe + He \rightarrow Xe_2^+ + He$	300°K	1.1×10^{-31}	134

Tabular Data B-1.27c.

Reaction	Temperature	Lifetime x Reaction Rate (cm^3)	Reference
$ArF^* + F_2 \rightarrow$ products	300^oK	7.6×10^{-18}	135
	300^oK	7.3×10^{-18}	128
$KrF^* + F_2 \rightarrow$ products	300^oK	5.2×10^{-18}	136
	300^oK	5.1×10^{-18}	137
$XeF^* + F_2 \rightarrow$ products	300^oK	5.3×10^{-18}	138
$XeF^* + NF_3 \rightarrow$ products	300^oK	2.4×10^{-19}	138
$XeF^* + Xe \rightarrow$ products	300^oK	4.6×10^{-19}	138
$XeF^* + Ar \rightarrow$ products	300^oK	1.3×10^{-20}	139
	300^oK	2.6×10^{-20}	138
$ArF^* + Ar \rightarrow$ products	300^oK	3.6×10^{-20}	135
$KrF^* + Kr \rightarrow$ products	300^oK	$\leq 1 \times 10^{-20}$	140
$Ar_2F^* + F_2 \rightarrow$ products	300^oK	3.8×10^{-17}	128
$ArF^* + Kr \rightarrow KrF^* + Ar$	300^oK	6.1×10^{-18}	135
$ArF^* + Xe \rightarrow XeF^* + Ar$	300^oK	1.8×10^{-17}	135
$Kr_2F^* + F_2 \rightarrow$ products	300^oK	7.8×10^{-17}	128

Tabular Data B-1.27d.

Reaction	Temperature	Lifetime x Reaction Rate (cm^6)	Reference
$ArF^* + 2\,Ar \rightarrow Ar_2F^* + Ar$	300°K	1.6×10^{-39}	135
	300°K	2.0×10^{-39}	128
$KrF^* + 2\,Kr \rightarrow Kr_2F^* + Kr$	300°K	4.2×10^{-39}	136
	300°K	4.5×10^{-39}	141
	300°K	2.6×10^{-39}	137
$KrF^* + 2\,Ar \rightarrow ArKrF^* + Ar$	300°K	5.2×10^{-40}	142
	300°K	8.1×10^{-40}	141
$KrF^* + Kr + Ar \rightarrow Kr_2F^* + Ar$	300°K	4.2×10^{-39}	142
$XeF^* + 2\,Ar \rightarrow$ products	300°K	2.4×10^{-40}	139
$XeF^* + Xe + Ar \rightarrow$ products	300°K	4.8×10^{-39}	139

Equations

Reaction rates as a function of temperature

Equations Cited in Table of Reactions
B-1.28.

1. $k=2.1\times10^{-10}EXP(-475.7/T)cm^3/s$
2. $k=3.3\times10^{-11}EXP(-591.8/T)cm^3/s$
3. $k=5.94\times10^{-10}T^{1/2}EXP(-18570/T)cm^3/s$
4. $k=1.2\times10^{-11}\ EXP(-40000/T)cm^3/s$
5. $k=1.2\times10^{-10}\ EXP(-42000/T)cm^3/s$
6. $k=9.3\times10^{-11}\ EXP(-39000/T)cm^3/s$
7. $k=7.0\times10^{-11}\ EXP(-35500/T)cm^3/s$
8. $k=6.58\times10^{-11}\ EXP(-24427/T)cm^3/s$
9. $k=4.40\times10^{-11}\ EXP(-23819/T)cm^3/s$
10. $k=6.98\times10^{2}(T)^{-2.85}\ EXP(-53395/T)cm^3/s$
11. $k=2.61\times10^{25}(T)^{-9.04}\ EXP(-46471/T)cm^3/s$
12. $k=1.02\times10^{11}(T)^{-4.64}\ EXP(-61667/T)cm^3/s$
13. $k=1.40\times10^{-3}(T)^{0.5}EXP(-38535/T)cm^3/s$
14. $k=3.77\times10^{6}(T)^{-4.0}EXP(-28907/T)cm^3/s$
15. $\log k(liters^2mole^{-2}sec^{-1})=(9.066\pm0.018)-(1.261\pm0.043)\log(T/300)$
16. $\log k(liters^2mole^{-2}sec^{-1})=9.136-1.716\log(T/300)+0.994\ \log^2(T/300)$
17. $\log k(liters^2mole^{-2}sec^{-1})=(9.17\pm0.024)-(1.423\pm0.057)\log(T/300)$
18. $k=4.03\times10^{-37}EXP(\ 6103/T)cm^6/s$
19. $\log k(liters^2mole^{-2}sec^{-1})=9.381\pm0.016-(2.287\pm0.125)\log(T/300)+(1.154\pm0.194)\log^2(T/300)$
20. $\log k(liters^2mole^{-2}sec^{-1})=(8.251\pm0.002)-(1.36\pm0.29)\log(T/2300)$
21. $\log k(liters^2mole^{-2}sec^{-1})=9.439-2.418\log(T/300)+1.911\ \log^2(T/300)$
22. $\log k(liters^2mole^{-2}sec^{-1})=(9.489\pm0.021)-(2.77\pm0.179)\log(T/300)+(1.473\pm0.298)\log^2(T/300)$
23. $\log k(liters^2mole^{-2}sec^{-1})=(9.614\pm0.024)-(3.484\pm0.195)\log(T/300)+(2.183\pm0.314)\log^2(T/300)$
24. $\log k(liters^2mole^{-2}sec^{-1})=9.652-2.787\ \log(T/300)+1.678\ \log^2(T/300)$

Equations Cited in Table of Reactions (Concluded)
B-1.28

25. $k=1.81x10^{-21}(T)^{-2.85}cm^6/s$

26. $k=4.11x10^{-2}(T)^{-9.04}EXP(-1152/T)cm^6/s$

27. $k=2.70x10^{-16}(T)^{-4.64}EXP(-1435/T)cm^6/s$

28. $k=1.97x10^{-30}T^{0.5}\ cm^6/s$

29. $k=1.31x10^{-13}EXP(-2154/T)cm^3/s$

30. $k=1.66x10^{-12}T^{0.5}EXP(-28007/T)cm^3/s$

31. $k=1.66x10^{-12}T^{0.5}EXP(-43134/T)cm^3/s$

32. $k=2.76x10^{10}EXP(-19800/R)(1.mol.^{-1})\ min^{-1}$

33. $k=3.29x10^{-13}T^{0.5}EXP(-1068/T)cm^3/s$

34. $k=3.60x10^{-14}T^{0.5}EXP(-1458/T)cm^3/s$

35. $logk(liters^2mole^{-2}sec^{-1})=(12.22\underline{+}2.00)-(4.3\underline{+}0.62)log(T/300)$

36. $logk(liters^2mole^{-2}sec^{-1})=(8.952\underline{+}0.002)-(2.70\underline{+}0.32)log(T/1545)$

37. $logk(liters^2mole^{-2}sec^{-1})=12.122-5.844\ log(T/300)+2.163\ log^2(T/300)$

38. $k=3.04x10^{-10}\ EXP(-23819/T)cm^3/s$

39. $\sigma^{\frac{1}{2}}=5.5-0.58\ ln\ E\ (E=1-70eV)$

40. $\sigma^{\frac{1}{2}}=6.9-0.25\ ln\ E\ (E=1-50eV)$

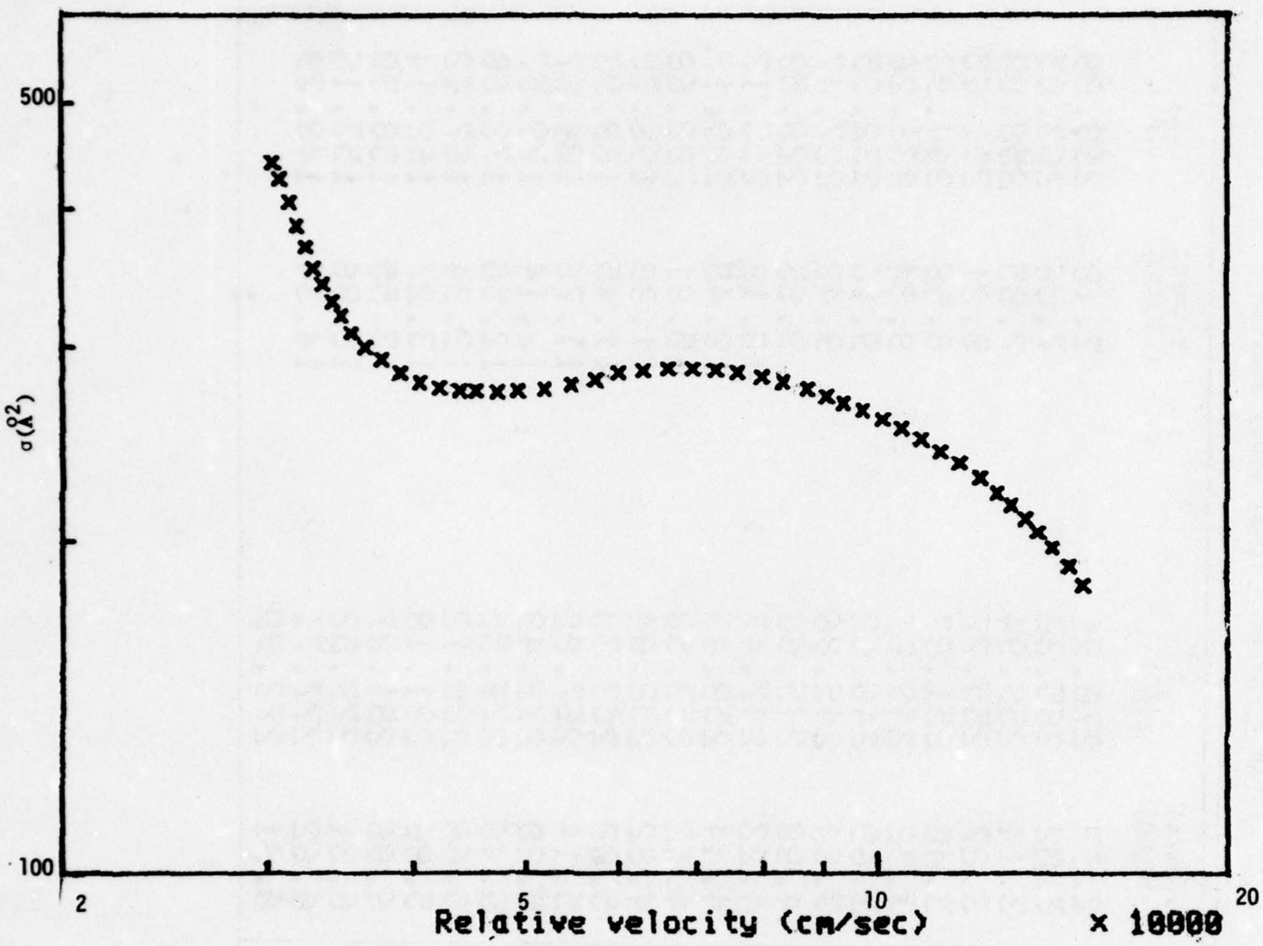
Tables and Graphs Cited in Table of Reactions

Reaction rates (k) and cross sections (σ) as a function of collision energy (E), temperature (T), and relative velocity (v).

Tabular Data B-1.29.

Table 1 He+Xe → Total Scattering

v(cm/s) (x10000)	σ(Å^2)	v(cm/s) (x10000)	σ(Å^2)
3.03	441.84	6.63	286.68
3.07	426.66	6.95	286.51
3.13	406.24	7.28	285.62
3.18	387.36	7.60	284.30
3.23	370.16	7.97	281.58
3.29	354.36	8.31	278.36
3.34	342.57	8.72	274.39
3.41	329.86	9.06	270.66
3.47	320.04	9.38	266.87
3.54	309.18	9.73	262.56
3.64	299.58	10.10	257.77
3.76	292.28	10.50	252.79
3.90	283.95	10.94	247.38
4.06	278.37	11.36	241.20
4.22	275.18	11.79	235.34
4.38	273.80	12.27	228.06
4.53	273.21	12.69	221.39
4.72	272.83	13.07	215.61
4.93	273.25	13.43	209.66
5.19	274.29	13.78	204.03
5.47	276.53	14.17	197.69
5.74	280.10	14.63	190.18
6.00	283.80	15.05	182.75
6.30	285.60		



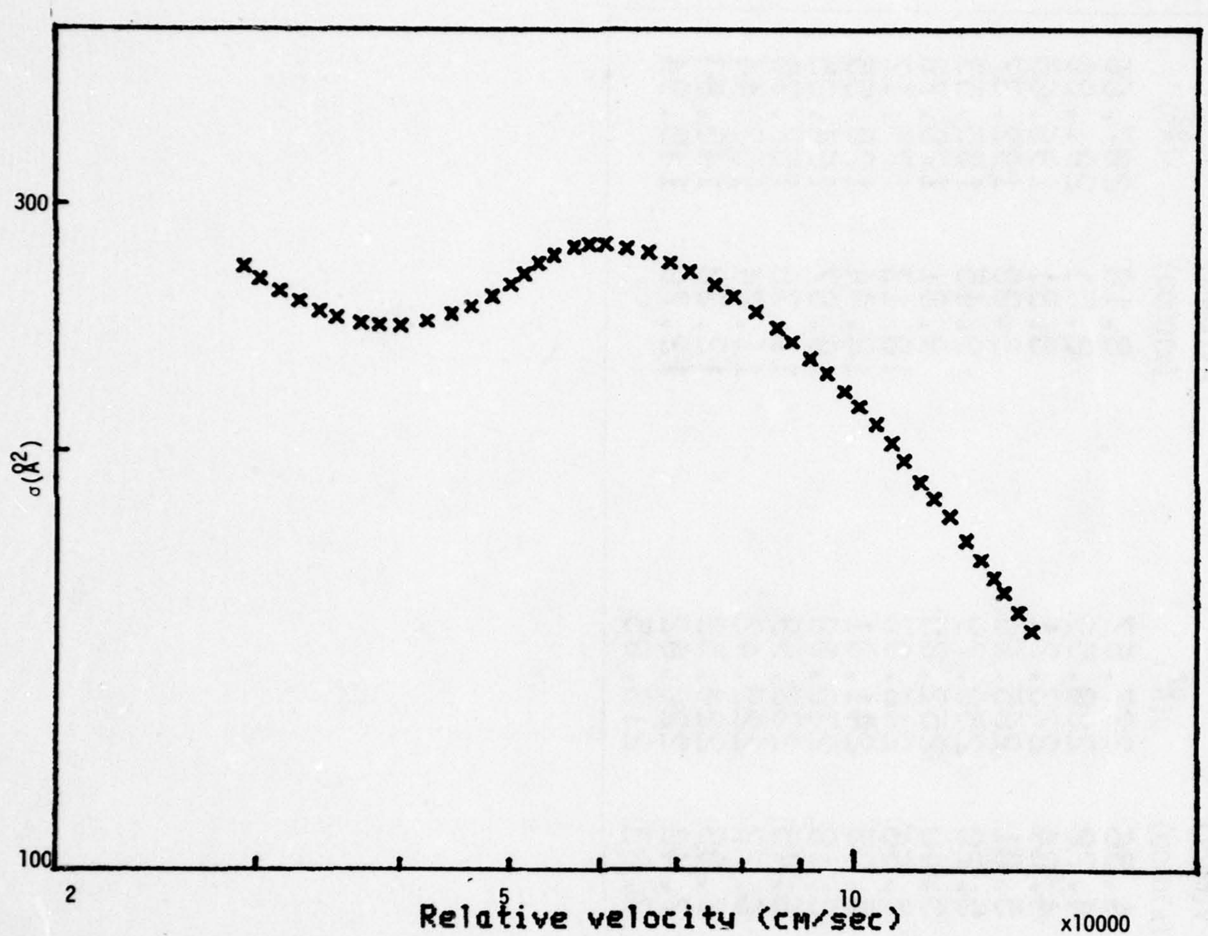
Graph 1 He+Xe → Total Scattering

Graphical Data B-1.30.

Tabular Data B-1.31.

Table 2 He+Kr → Total Cross Section

v(cm/s) (x10000)	$\sigma(Å^2)$	v(cm/s) (x10000)	$\sigma(Å^2)$
2.92	270.91	7.18	268.89
3.02	265.30	7.56	263.05
3.14	259.94	7.85	258.00
3.27	255.77	8.21	251.65
3.40	251.67	8.56	244.93
3.52	249.01	8.84	239.26
3.69	246.62	9.16	232.85
3.84	245.86	9.47	227.47
4.00	245.63	9.83	220.59
4.23	247.47	10.12	215.17
4.44	250.43	10.48	209.17
4.62	253.58	10.81	202.68
4.82	258.04	11.09	196.78
5.00	263.30	11.45	189.93
5.14	267.85	11.76	184.87
5.28	272.49	12.14	179.57
5.46	276.35	12.55	172.60
5.68	280.12	12.94	167.12
5.86	281.18	13.27	162.14
6.06	281.07	13.55	158.30
6.31	279.52	13.96	153.16
6.62	277.71	14.34	148.39
6.91	272.99		



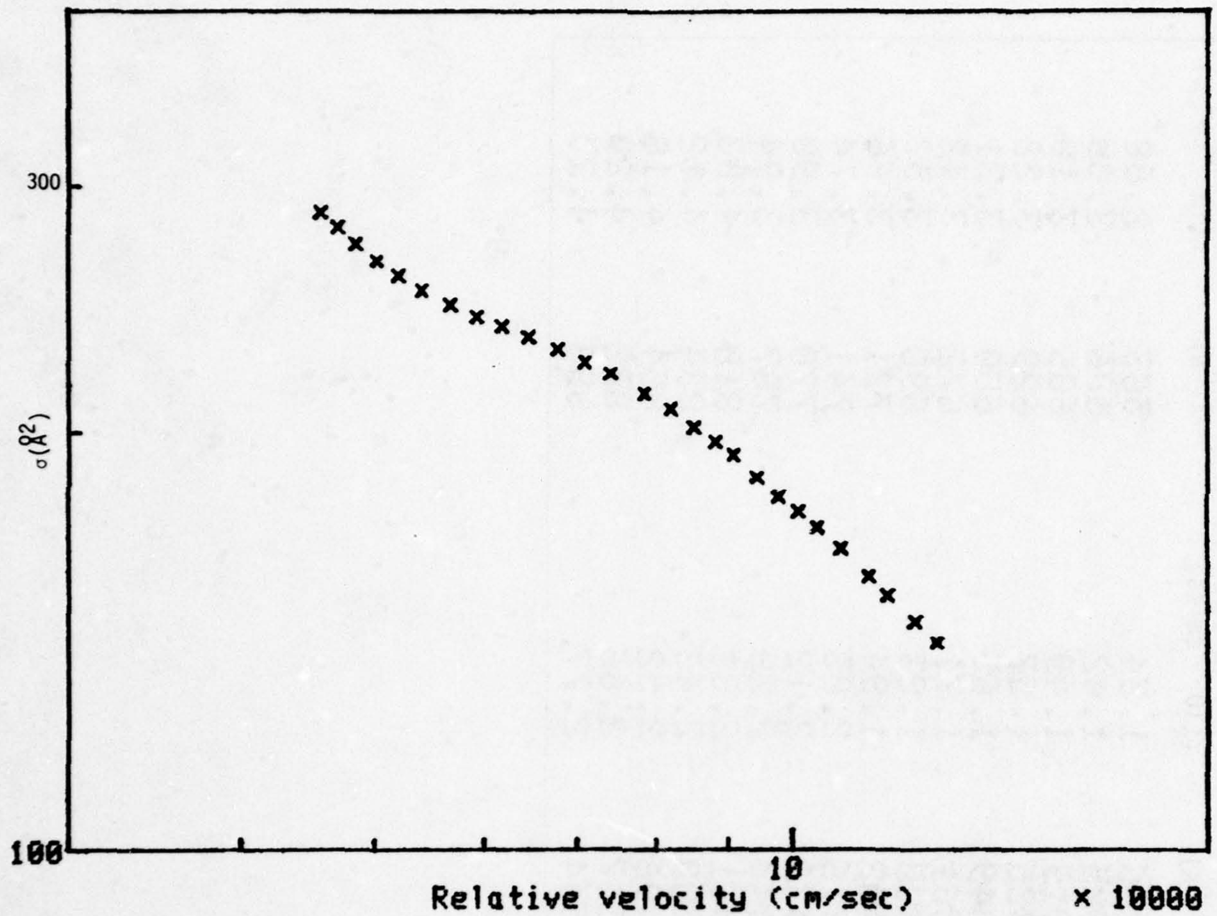
Graph 2 He+Kr → Total Cross Section

Graphical Data B-1.32.

Tabular Data B-1.33.

Table3 He+Ar → Total Cross Section

v(cm/s) (x10000)	$\sigma(\mathring{A}^2)$	v(cm/s) (x10000)	$\sigma(\mathring{A}^2)$
4.56	287.67	8.18	207.66
4.70	280.59	8.51	201.80
4.84	273.21	8.81	196.65
5.01	265.66	9.08	192.37
5.20	258.79	9.45	185.53
5.40	252.85	9.81	179.70
5.66	246.83	10.13	175.17
5.93	241.81	10.44	170.55
6.18	238.08	10.87	164.85
6.45	233.99	11.38	157.30
6.77	229.42	11.74	152.44
7.09	224.52	12.30	145.83
7.40	220.02	12.76	140.94
7.83	213.05		



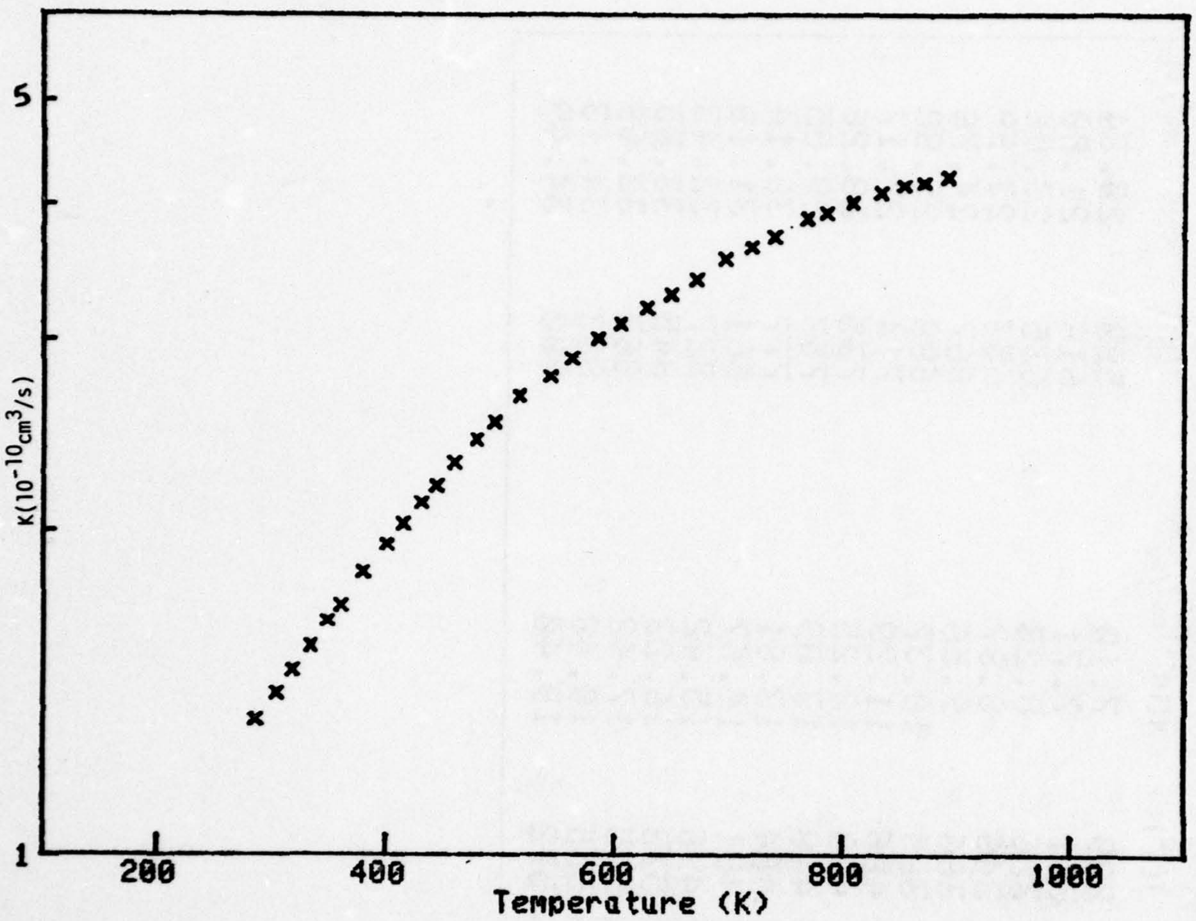
Graph 3 He+Ar → Total Cross Section

Graphical Data B-1.34.

Tabular Data B-1.35.

Table 4 $He(2^3S)+Xe \rightarrow$ Quenching

$T(^oK)$	$K(10^{-10}cm^3/s)$	$T(^oK)$	$K(10^{-10}cm^3/s)$
286	1.34	563	2.88
305	1.42	586	3.00
319	1.49	606	3.10
335	1.57	629	3.22
349	1.65	650	3.31
361	1.71	672	3.42
380	1.83	698	3.57
402	1.94	721	3.66
416	2.03	741	3.74
432	2.12	770	3.90
444	2.20	787	3.94
461	2.31	810	4.03
480	2.43	834	4.12
496	2.52	854	4.18
517	2.66	872	4.20
544	2.77	893	4.25



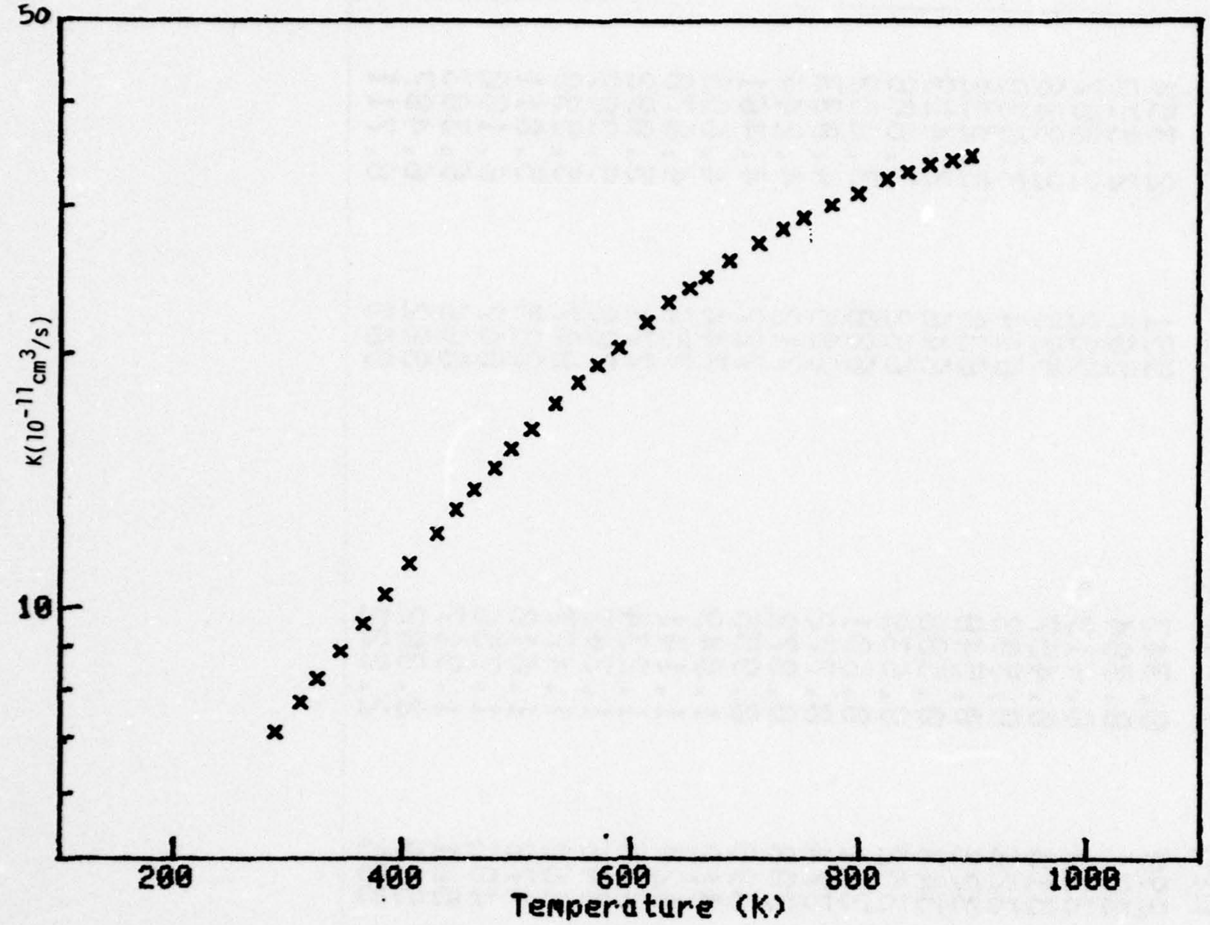
Graph 4 $He(2^3S)+Xe \rightarrow$ Quenching

Graphical Data B-1.36.

Tabular Data B-1.37.

Table 5 $He(2^3S)+Ar \rightarrow$ Quenching

$T(K^o)$	$K(10^{-11}cm^3/s)$	$T(K^o)$	$K(10^{-11}cm^3/s)$
289	7.10	590	20.34
311	7.71	616	21.80
326	8.23	635	23.06
346	8.87	653	23.99
366	9.56	667	24.76
385	10.37	688	25.88
406	11.29	714	27.17
430	12.25	735	28.26
448	13.09	753	29.05
464	13.81	777	30.14
481	14.67	801	31.10
496	15.42	827	32.43
513	16.23	845	33.03
535	17.42	863	33.69
555	18.48	883	34.13
572	19.40	900	34.49



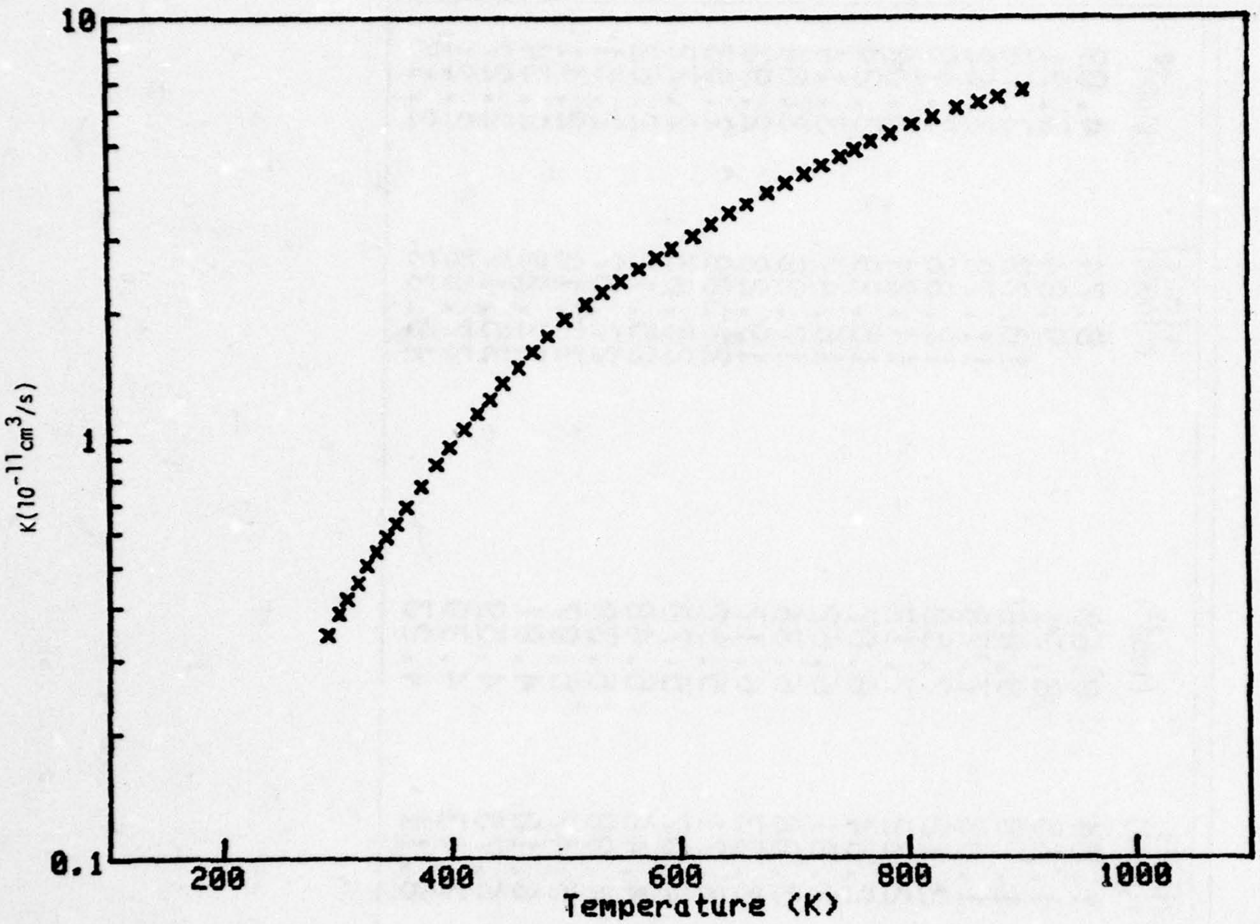
Graph 5 He(2^3S) + Ar → Quenching

Graphical Data B-1.38.

Tabular Data B-1.39.

Table 6 He(2^3S)+Ne → Quenching

T(K^0)	K($10^{-11}cm^3/s$)	T(K^0)	K($10^{-11}cm^3/s$)
290	0.343	551	2.354
301	0.384	567	2.530
309	0.419	582	2.687
318	0.457	595	2.836
326	0.503	614	3.039
335	0.540	630	3.232
343	0.588	646	3.429
352	0.630	662	3.608
361	0.691	680	3.852
374	0.772	695	4.033
388	0.872	712	4.244
399	0.955	727	4.461
412	1.049	744	4.695
424	1.141	756	4.870
435	1.234	771	5.092
446	1.347	788	5.289
460	1.477	807	5.580
472	1.610	825	5.811
486	1.756	847	6.100
501	1.917	866	6.303
519	2.082	882	6.487
535	2.222	903	6.711



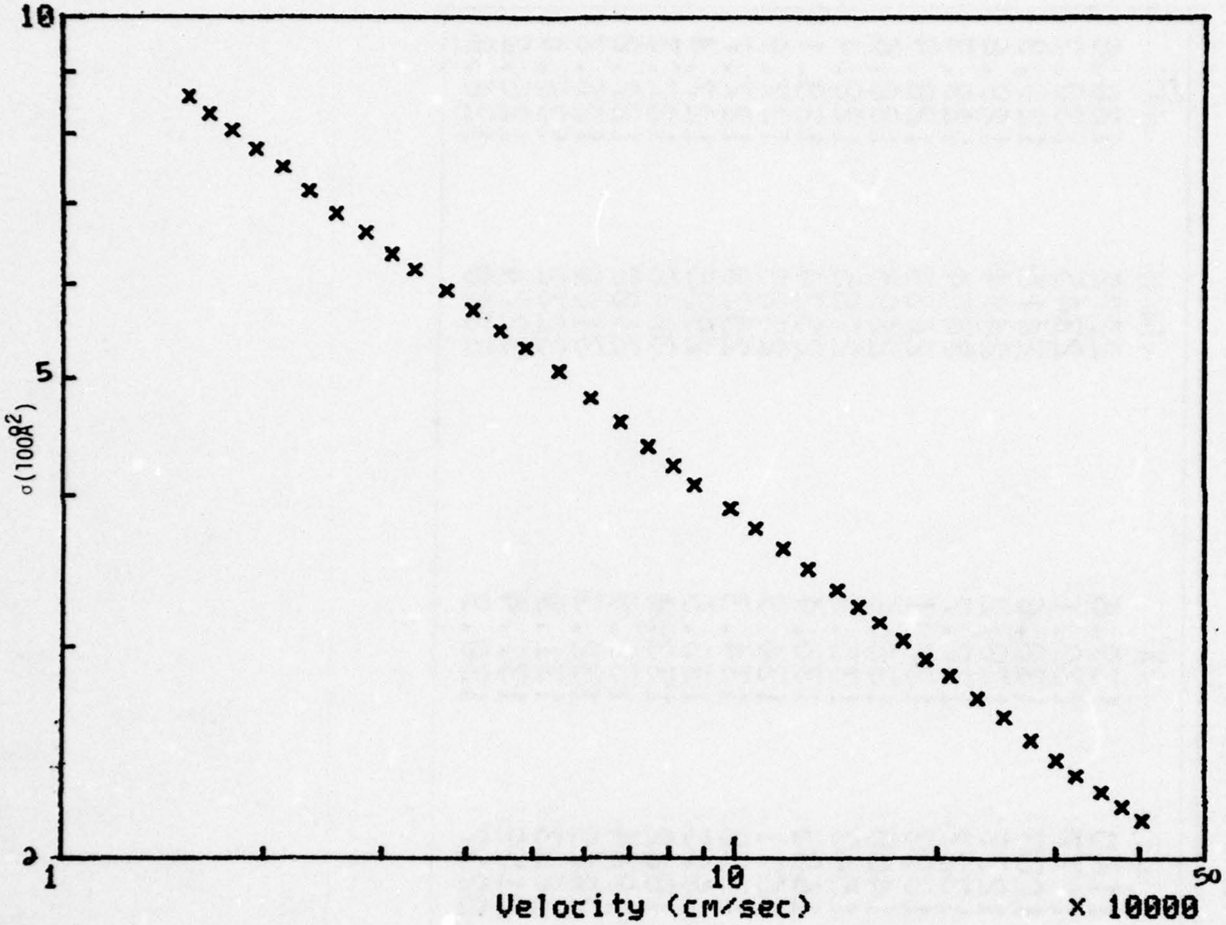
Graph 6 $He(2^3S) + Ne \rightarrow$ Quenching

Graphical Data B-1.40.

Tabular Data B-1.41.

Table 7 Ar+Ar → Total Elastic Cross Section

v(cm/s) (x10000)	$\sigma(100\text{Å}^2)$	v(cm/s) (x10000)	$\sigma(100\text{Å}^2)$
1.54	8.60	8.74	4.09
1.65	8.31	9.84	3.91
1.78	8.06	10.73	3.76
1.93	7.78	11.78	3.62
2.12	7.50	12.86	3.48
2.32	7.17	14.24	3.34
2.54	6.87	15.29	3.24
2.81	6.62	16.47	3.14
3.08	6.36	17.83	3.04
3.33	6.17	19.28	2.93
3.71	5.92	20.88	2.83
4.07	5.70	23.05	2.72
4.46	5.48	25.18	2.62
4.88	5.30	27.57	2.51
5.47	5.07	30.10	2.41
6.10	4.81	32.25	2.34
6.75	4.59	35.17	2.27
7.43	4.39	37.68	2.21
8.11	4.23	40.33	2.15



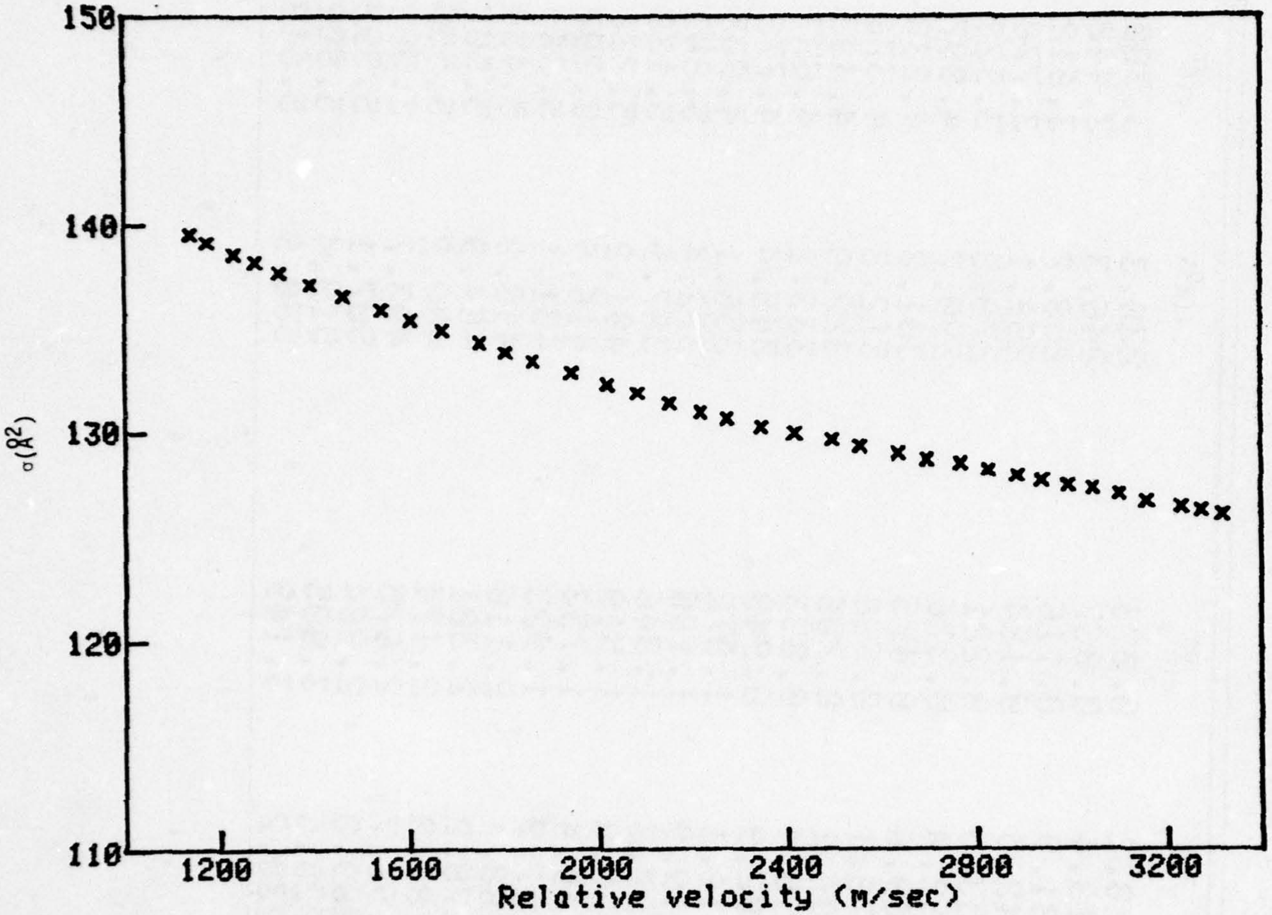
Graph 7 Ar+Ar → Elastic Cross Section

Graphical Data B-1.42.

Tabular Data B-1.43.

Table 8 $He(2^3S_1)+He \rightarrow$ Total Scattering

v(m/s)	$\sigma(\mathring{A}^2)$	v(m/s)	$\sigma(\mathring{A}^2)$
1140	139.6	2272	130.6
1177	139.1	2345	130.2
1233	138.6	2415	129.9
1277	138.2	2494	129.6
1327	137.7	2554	129.3
1393	137.1	2633	128.9
1460	136.6	2695	128.6
1543	135.9	2765	128.4
1605	135.4	2824	128.1
1671	134.9	2885	127.9
1750	134.3	2938	127.7
1805	133.9	2995	127.4
1862	133.4	3046	127.3
1944	132.9	3102	127.0
2019	132.3	3160	126.6
2083	131.9	3232	126.4
2152	131.4	3274	126.2
2217	130.9	3319	126.0

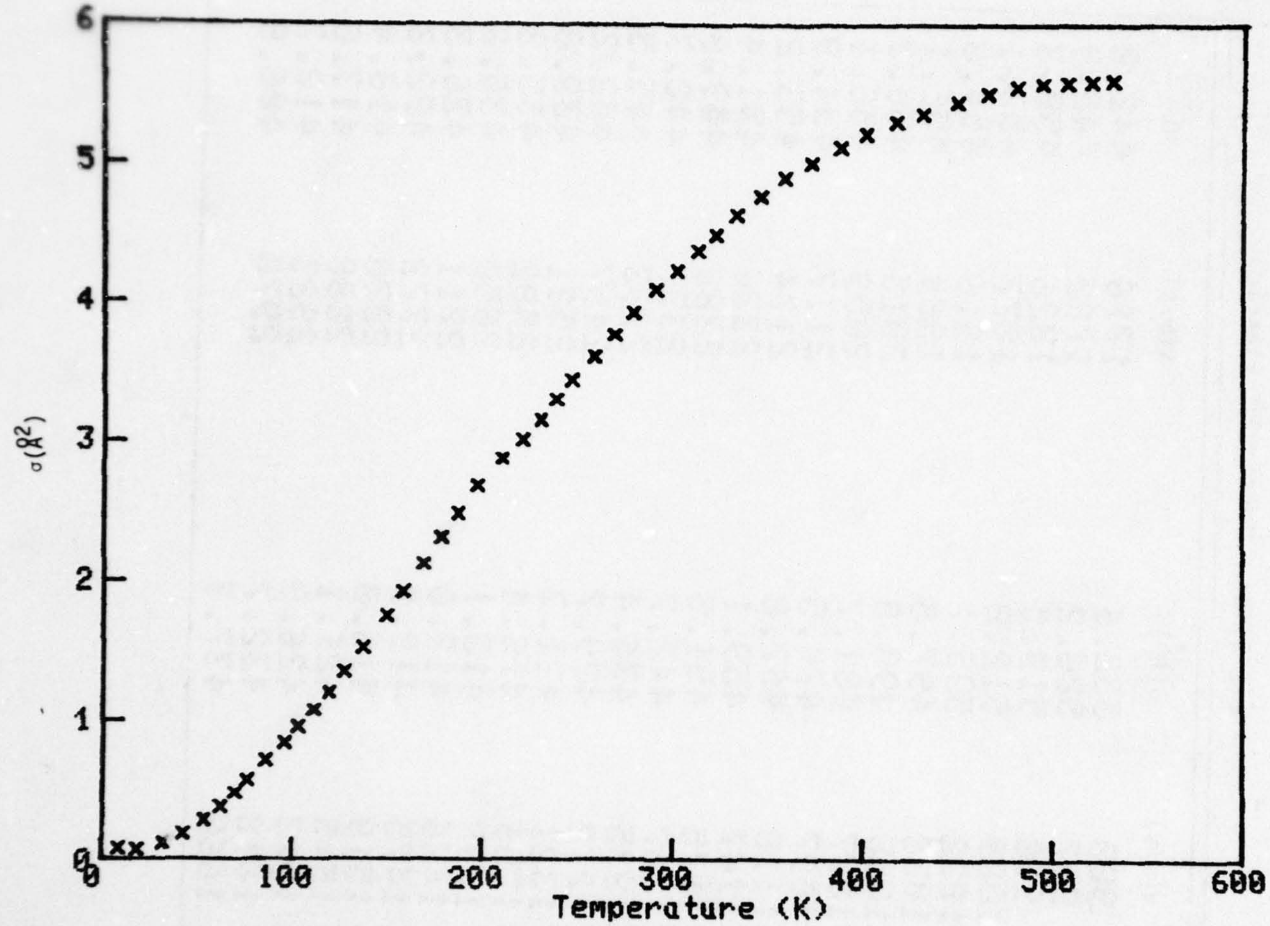


Graph 8 $He(2^3S_1)+He \rightarrow$ Total Scattering

Graphical Data B-1.44.

Table 9 $He^3(2^3S_1)+He^3 \rightarrow He^3+He^3(2^3S_1)$

$T(K^o)$	$\sigma(\mathring{A}^2)$	$T(K^o)$	$\sigma(\mathring{A}^2)$
8.2	0.075	238.3	3.300
18.4	0.067	246.3	3.440
31.9	0.116	258.7	3.612
42.5	0.184	269.1	3.770
53.5	0.281	278.8	3.928
62.[illegible]	0.376	290.7	4.097
69.6	0.475	301.8	4.238
76.1	0.568	312.8	4.376
86.1	0.706	322.0	4.493
95.4	0.833	333.2	4.637
102.9	0.949	345.4	4.772
111.1	1.072	358.1	4.903
119.0	1.196	372.4	5.009
127.3	1.346	387.9	5.130
136.8	1.519	401.2	5.222
149.4	1.753	416.9	5.307
157.9	1.923	431.1	5.369
168.1	2.116	448.8	5.454
178.2	2.301	464.9	5.507
187.0	2.474	480.2	5.559
196.7	2.675	493.7	5.582
209.8	2.864	507.1	5.590
220.6	3.005	519.4	5.602
230.2	3.149	530.9	5.613



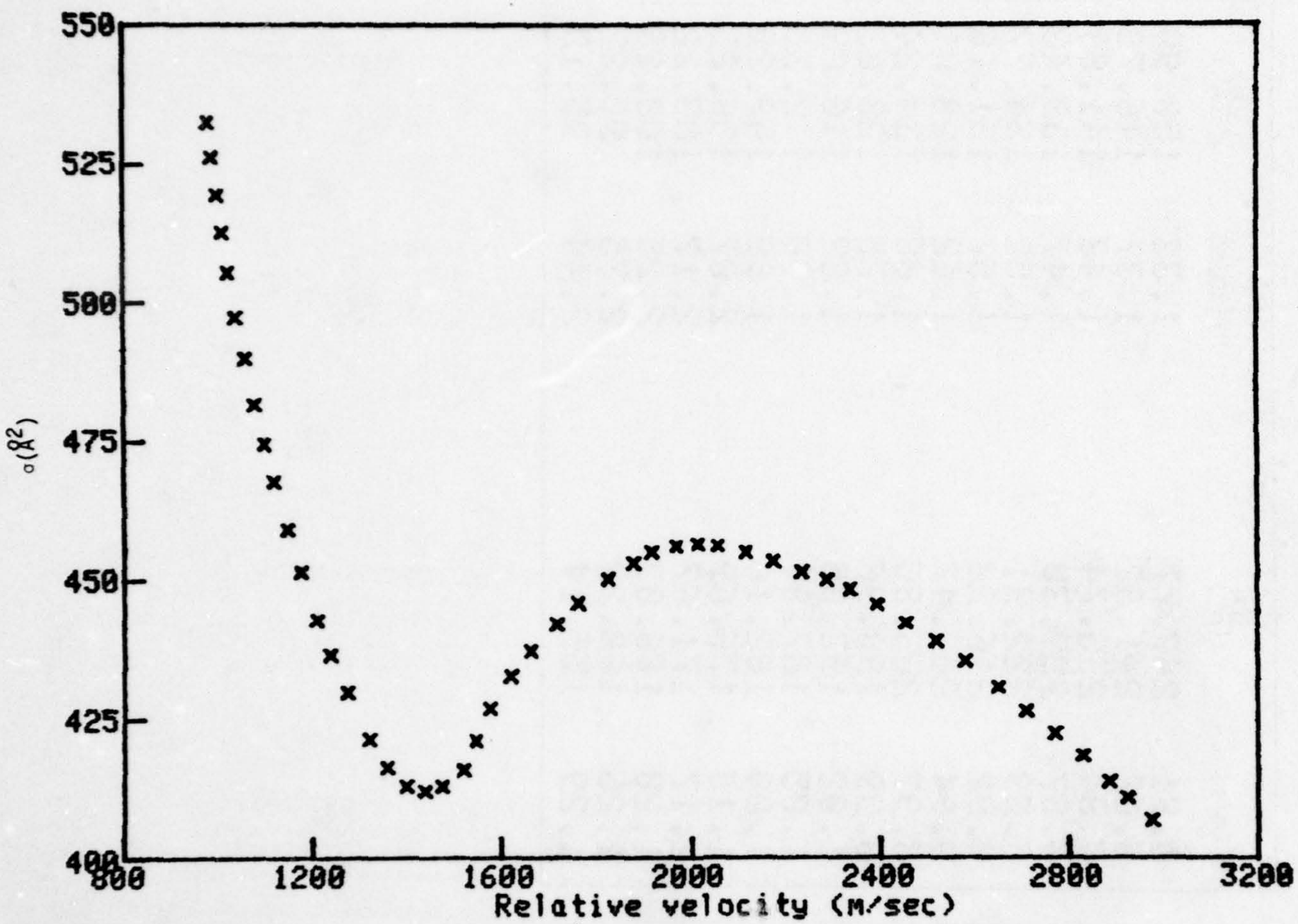
Graph 9 $He^3(2^3S_1)+He^3 \rightarrow He^3+He^3(2^3S_1)$

Graphical Data B-1.46.

Tabular Data B-1.47.

$He(2^3S)+Kr \rightarrow$ Total (97% Elastic)

v(m/s)	σ(Å^2)	v(m/s)	σ(Å^2)
980	532.6	1716	442.0
987	526.2	1762	445.8
998	519.5	1826	450.3
1009	512.8	1877	453.1
1022	505.7	1918	454.8
1038	497.5	1969	456.1
1058	490.0	2015	456.3
1077	481.7	2059	456.1
1097	474.5	2117	454.9
1118	467.8	2174	453.2
1147	459.1	2236	451.4
1175	451.5	2288	449.9
1207	442.7	2337	448.3
1235	436.4	2393	445.5
1272	429.7	2457	442.2
1321	421.3	2521	439.0
1356	416.4	2582	435.2
1398	413.1	2650	430.6
1436	412.0	2711	426.3
1475	412.9	2772	422.3
1519	416.0	2830	418.4
1545	421.1	2888	413.6
1573	426.9	2925	410.7
1618	432.7	2976	406.8
1660	437.3		



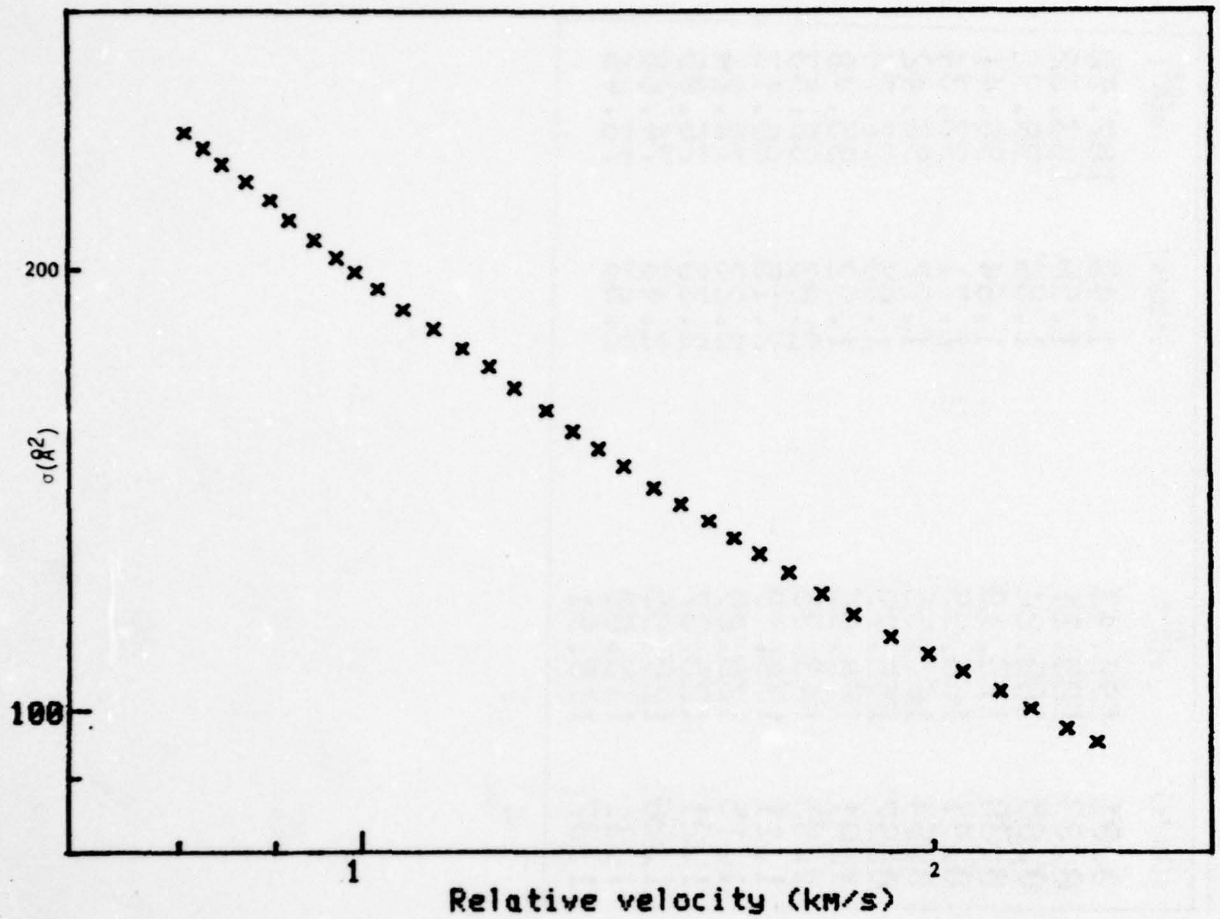
Graph 10 $He(2^3S) + Kr \rightarrow$ Total (97% Elastic)

Graphical Data B-1.48.

Tabular Data B-1.49.

Table 11 He+Xe → Elastic Scattering

v(km/s)	σ(Å^2)	v(km/s)	σ(Å^2)
0.81	247.77	1.33	150.90
0.82	241.82	1.37	146.78
0.84	235.74	1.43	141.89
0.87	229.30	1.47	138.48
0.89	222.91	1.52	134.77
0.92	216.20	1.57	131.16
0.94	209.47	1.62	128.01
0.97	203.86	1.68	124.24
0.99	198.96	1.75	120.03
1.02	193.85	1.82	116.09
1.05	187.81	1.90	112.35
1.09	182.16	1.99	109.22
1.13	176.69	2.07	106.23
1.17	171.67	2.17	103.22
1.20	166.03	2.25	100.28
1.25	160.22	2.35	97.27
1.29	155.14	2.44	95.10



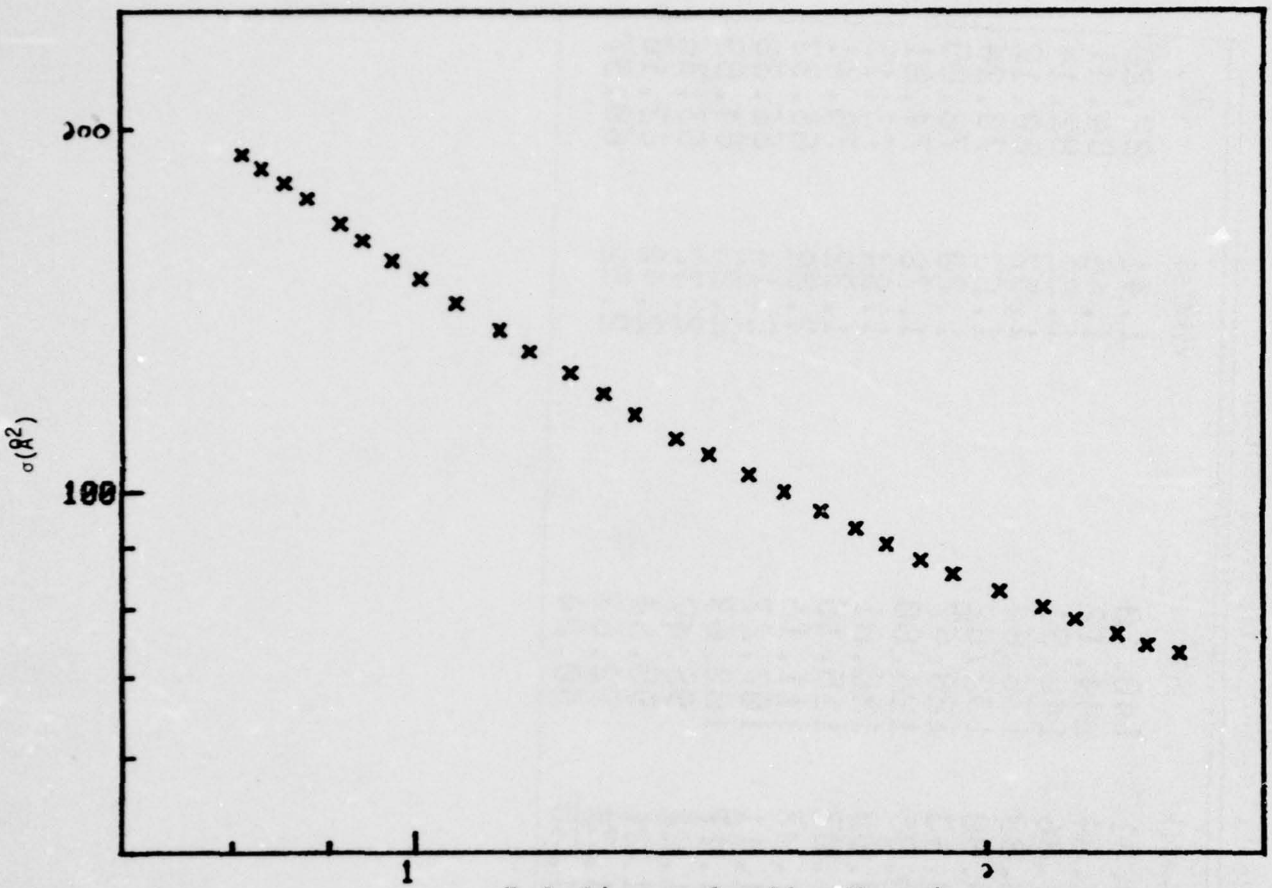
Graph 11 He+Xe → Elastic Scattering

Graphical Data B-1.50.

Tabular Data B-1.51.

Table 12 He+Kr → Total Elastic

v(km/s)	$\sigma(\AA^2)$	v(km/s)	$\sigma(\AA^2)$
0.81	190.43	1.43	107.50
0.83	185.21	1.50	103.32
0.85	180.24	1.56	99.92
0.88	175.10	1.64	96.41
0.91	166.95	1.71	93.34
0.94	161.55	1.77	90.42
0.97	155.79	1.85	87.74
1.01	150.06	1.92	85.48
1.05	143.33	2.03	82.53
1.11	136.19	2.15	80.13
1.15	130.89	2.23	78.24
1.21	125.37	2.35	76.09
1.26	120.55	2.43	74.60
1.31	115.80	2.53	73.46
1.37	110.91		



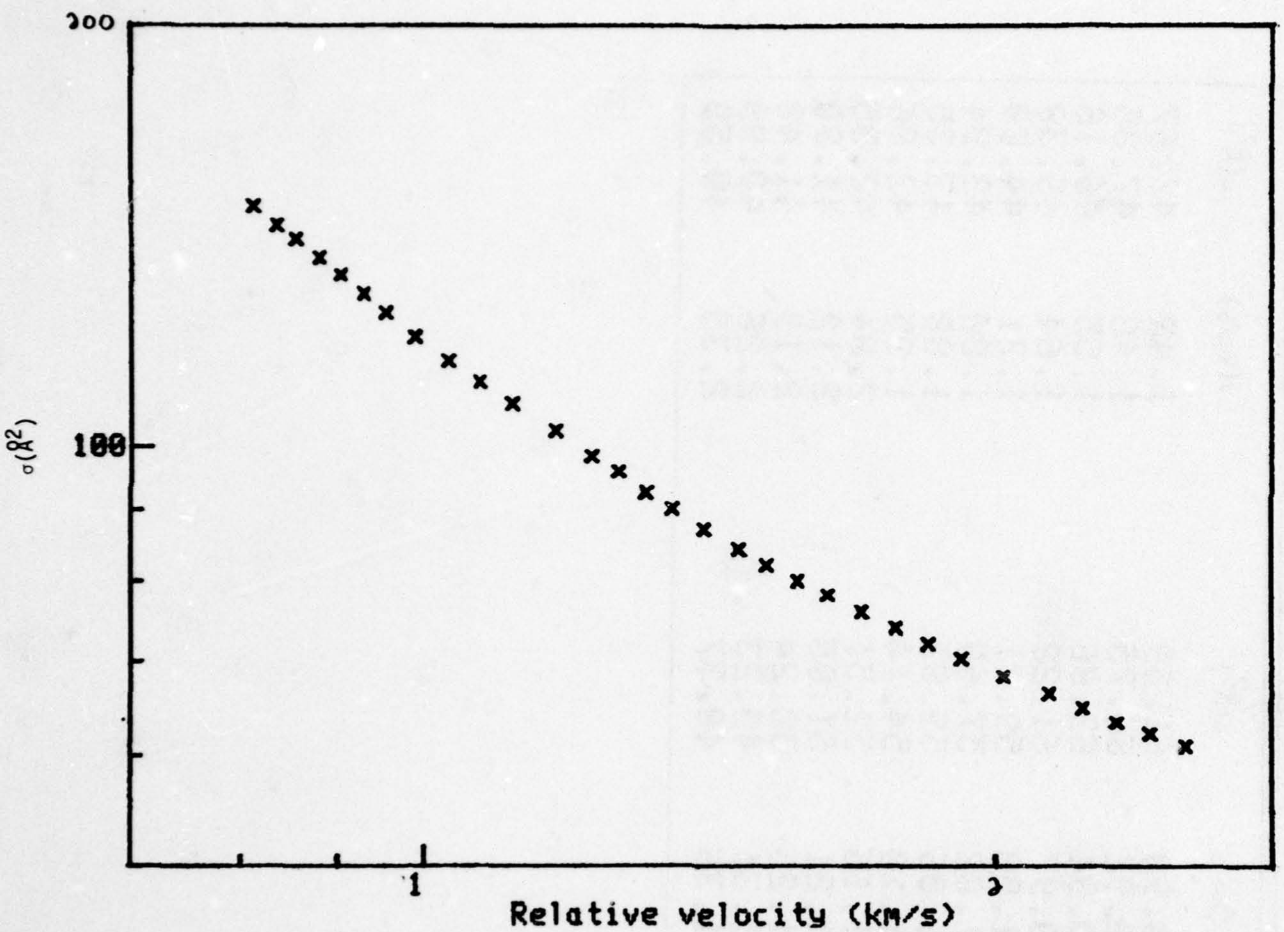
Graph 12 He+Kr → Total Elastic

Graphical Data B-1.52.

Tabular Data B-1.53.

Table 13 He+Ar→Elastic Cross Section

v(km/s)	$\sigma(\AA^2)$	v(km/s)	$\sigma(\AA^2)$
0.81	148.60	1.41	87.28
0.84	144.12	1.46	84.41
0.86	140.81	1.52	82.14
0.88	136.64	1.57	80.12
0.90	132.82	1.63	78.24
0.93	128.67	1.70	76.05
0.95	124.80	1.78	74.01
0.99	120.01	1.84	72.15
1.03	115.15	1.92	70.41
1.07	111.11	2.02	68.33
1.11	107.27	2.14	66.38
1.17	102.63	2.23	64.89
1.22	98.47	2.32	63.36
1.26	95.94	2.42	62.16
1.31	92.63	2.52	60.97
1.35	90.24		



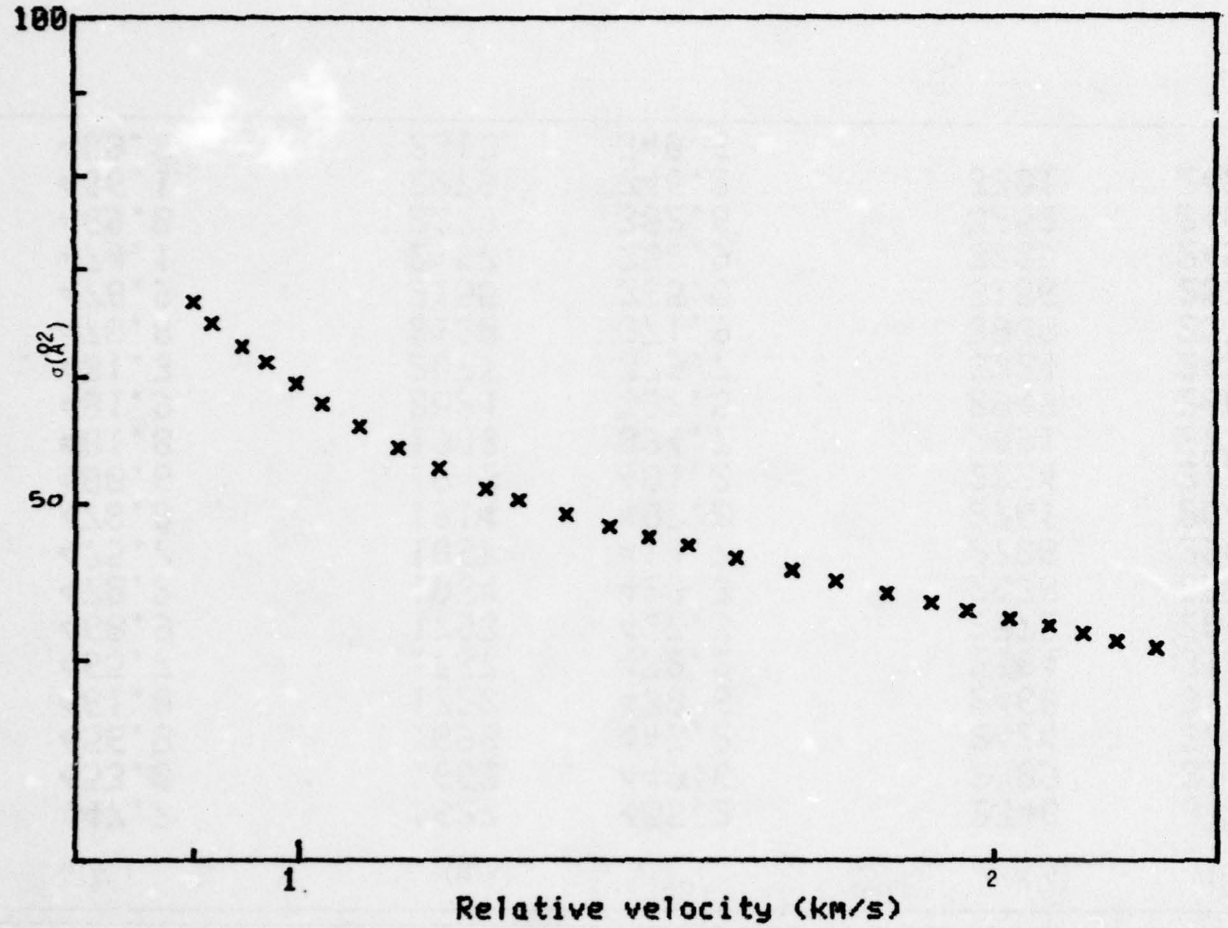
Graph 13 H_2+Ar → Elastic Cross Section

Graphical Data B-1.54.

Tabular Data B-1.55.

Table 14 He+Ne → Total Cross Section

v(km/s)	σ(Å^2)	v(km/s)	σ(Å^2)
0.90	66.69	1.42	47.67
0.92	64.75	1.48	47.05
0.94	62.66	1.55	46.18
0.97	61.22	1.64	45.38
1.00	59.31	1.71	44.69
1.02	57.69	1.80	43.94
1.06	55.82	1.88	43.35
1.10	54.14	1.95	42.86
1.15	52.51	2.04	42.35
1.21	51.05	2.12	41.90
1.25	50.24	2.19	41.48
1.31	49.23	2.26	40.99
1.36	48.37	2.35	40.59



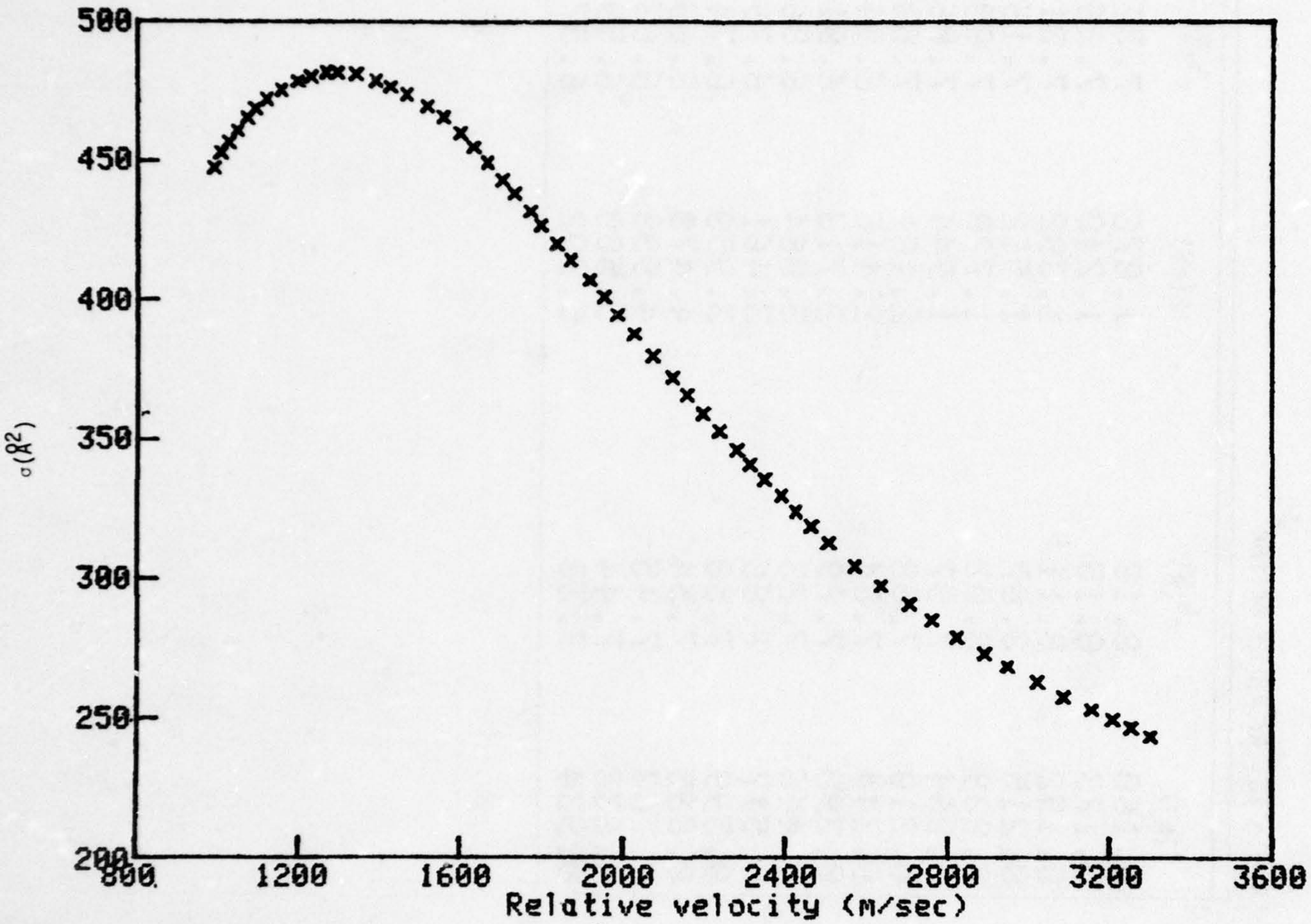
Graph 14 He+Ne → Total Cross Section

Graphical Data B-1.56.

Tabular Data B-1.57.

Table 15 $He(2^3S)+Ar \rightarrow$ Total Scattering

V(m/s)	σ(Å^2)	v(m/s)	σ(Å^2)	v(m/s)	v(Å^2)
988	447.7	1627	455.2	2346	335.4
1006	453.0	1662	449.6	2389	329.8
1024	456.8	1698	443.2	2424	324.0
1046	461.0	1728	438.6	2460	318.6
1070	465.7	1767	432.2	2504	312.6
1091	468.9	1793	427.3	2572	304.2
1118	472.2	1834	420.3	2636	297.2
1154	475.7	1867	414.7	2706	290.8
1195	478.8	1914	407.2	2761	284.9
1226	480.6	1949	401.2	2824	279.0
1264	481.8	1983	394.7	2891	273.1
1292	481.9	2024	387.5	2949	268.3
1339	481.3	2071	379.7	3024	262.8
1387	478.8	2120	371.9	3088	257.8
1423	476.9	2155	365.5	3156	253.1
1463	474.1	2197	358.9	3209	249.4
1513	469.8	2239	352.6	3252	246.6
1554	466.1	2279	346.2	3301	243.5
1595	460.2	2313	340.6		



Graph 15 $He(2^3S)+Ar \rightarrow$ Total Scattering

Graphical Data B-1.58.

Tabular Data B-1.59.

Table 16 $Ar^+ + Ar \rightarrow Ar + Ar^+$

E(eV)	$\sigma^{1/2}$(Å)	E(eV)	$\sigma^{1/2}$(Å)
0.160	8.18	1.076	7.32
0.173	8.15	1.240	7.26
0.192	8.11	1.392	7.21
0.215	8.07	1.562	7.16
0.239	8.02	1.778	7.08
0.264	7.97	1.944	7.06
0.310	7.88	2.161	7.00
0.344	7.84	2.416	6.94
0.390	7.79	2.713	6.91
0.446	7.73	3.064	6.86
0.517	7.66	3.461	6.79
0.599	7.58	3.958	6.74
0.665	7.54	4.470	6.69
0.763	7.45	4.998	6.63
0.833	7.44	5.500	6.59
0.934	7.38	5.992	6.57

AD-A053 827 ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND REDSTO--ETC F/G 20/5
COMPILATION OF DATA RELEVANT TO RARE GAS-RARE GAS AND RARE GAS---ETC(U)
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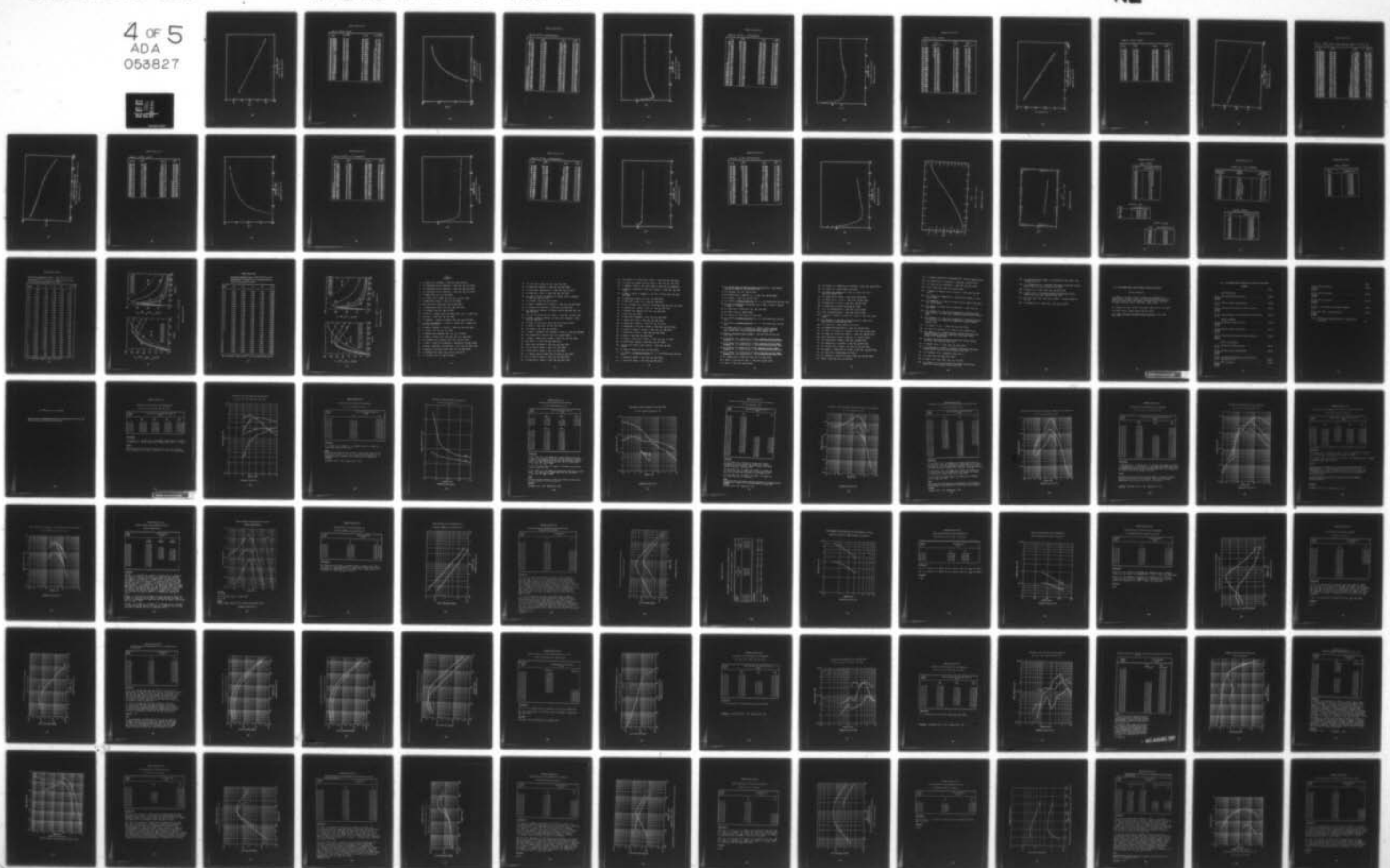

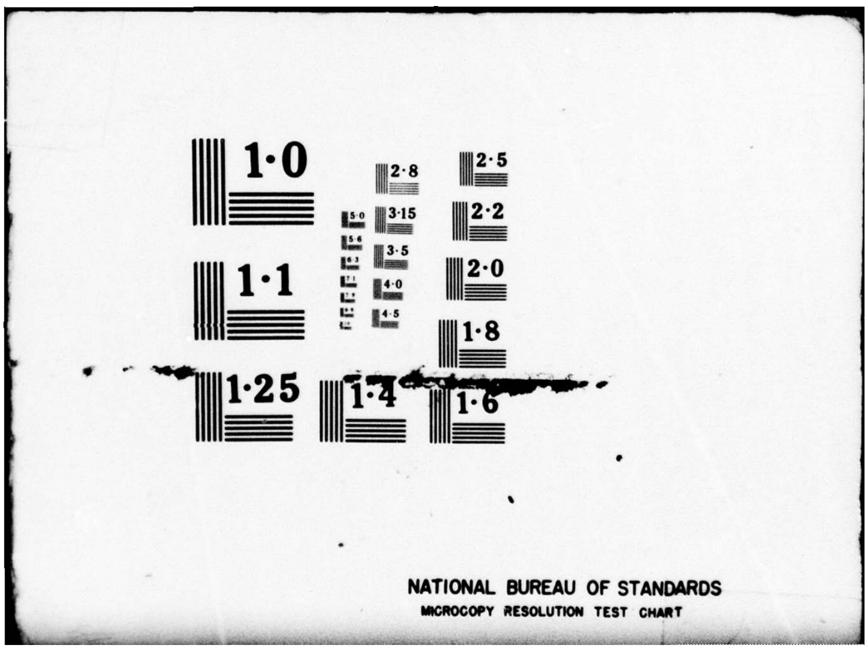
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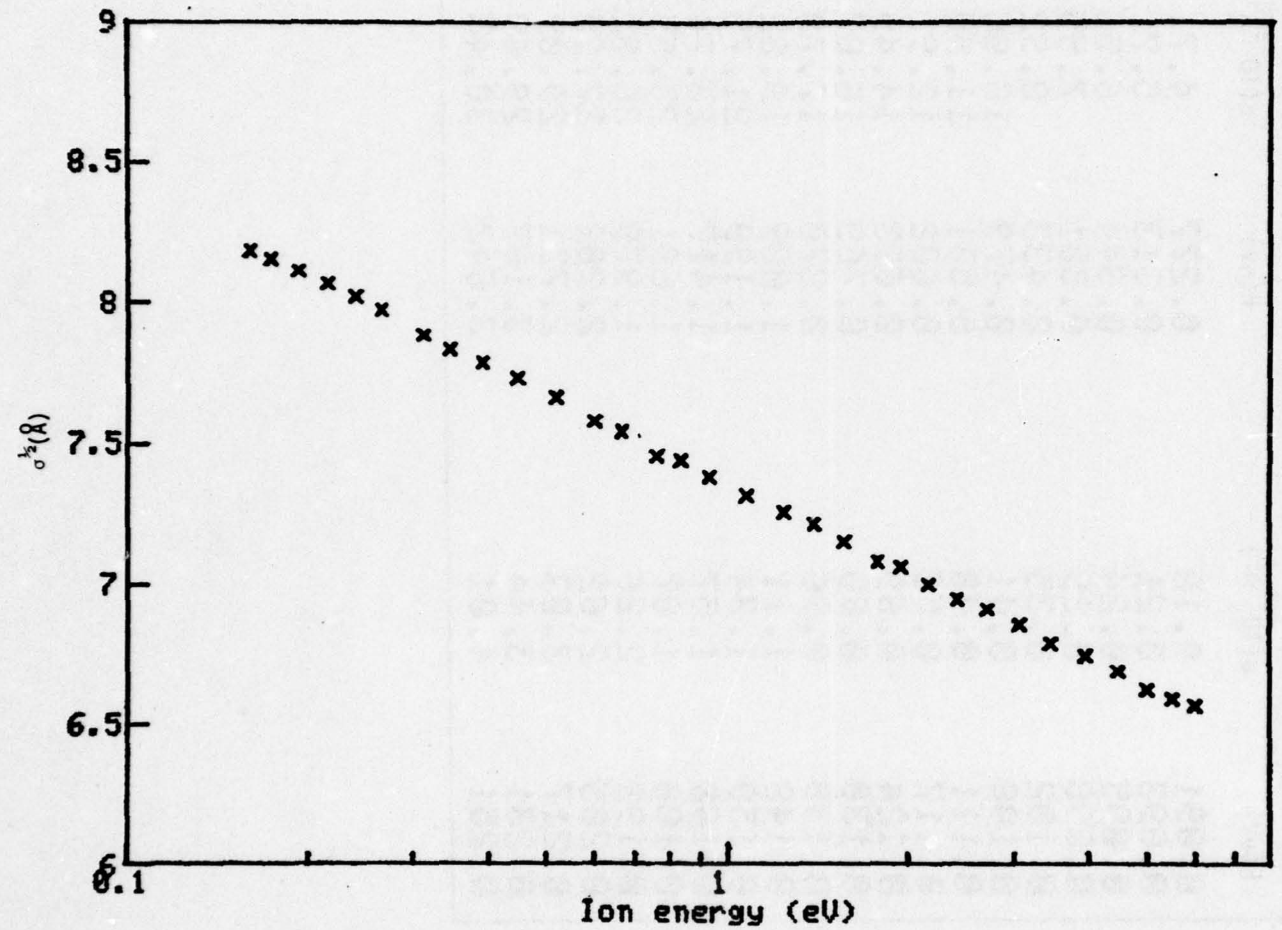
MICROCOPY RESOLUTION TEST CHART



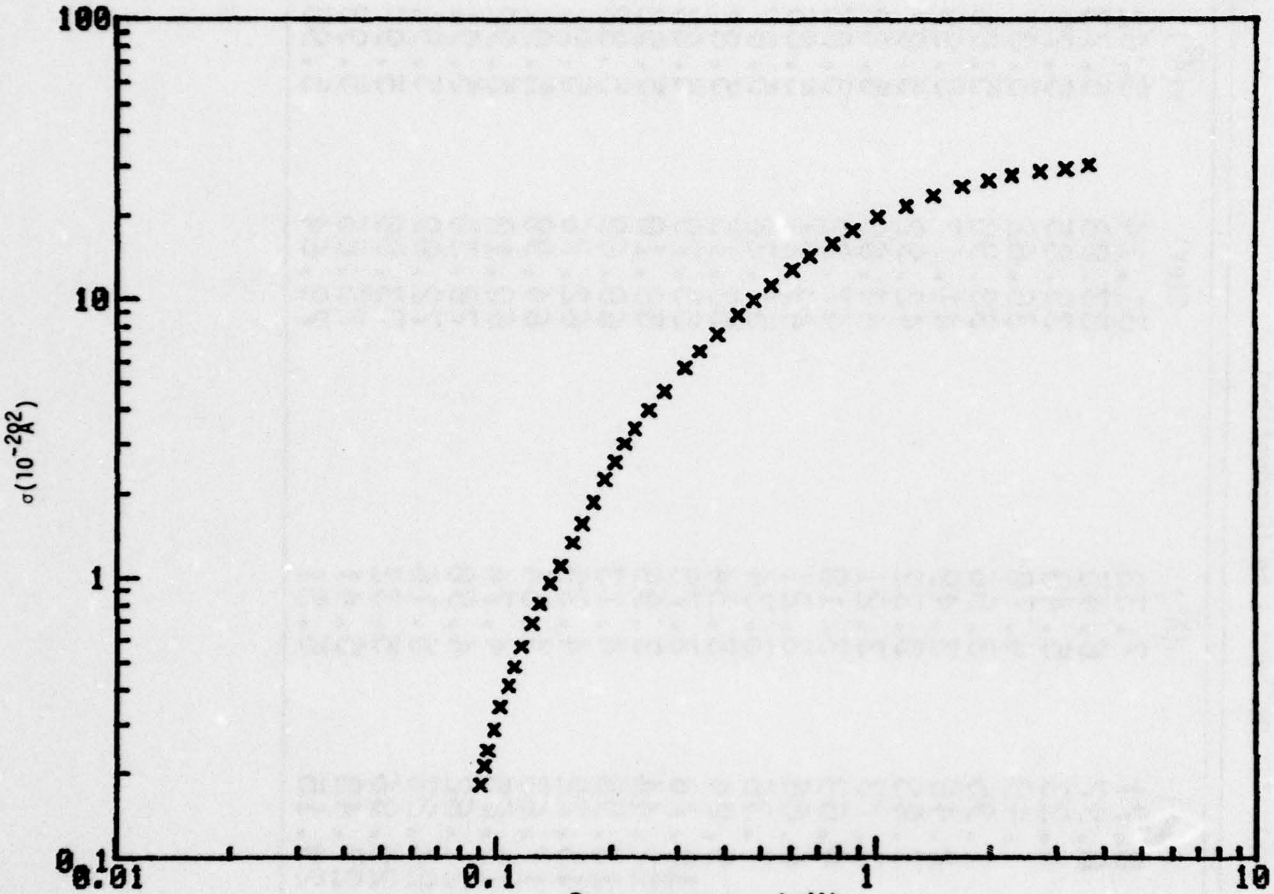
Graph 16 $Ar^+ + Ar \rightarrow Ar + Ar^+$

Graphical Data B-1.60.

Tabular Data B-1.61.

Table 17 $Ne^+ + Ar \rightarrow Ne + Ar^+$

E(eV)	$\sigma(10^{-20} Å^2)$	E(eV)	$\sigma(10^{-20} Å^2)$
0.091	0.18	0.277	4.71
0.093	0.21	0.313	5.71
0.095	0.24	0.344	6.56
0.098	0.29	0.381	7.55
0.102	0.35	0.433	8.92
0.108	0.41	0.479	10.06
0.111	0.48	0.531	11.40
0.117	0.56	0.602	12.91
0.124	0.69	0.673	14.49
0.130	0.80	0.769	16.07
0.139	0.96	0.870	17.78
0.148	1.11	1.009	19.82
0.159	1.34	1.199	21.78
0.168	1.57	1.417	23.74
0.180	1.87	1.691	25.55
0.192	2.26	1.979	26.82
0.205	2.62	2.282	27.95
0.217	3.03	2.721	29.09
0.231	3.44	3.163	29.69
0.251	4.01	3.642	30.43



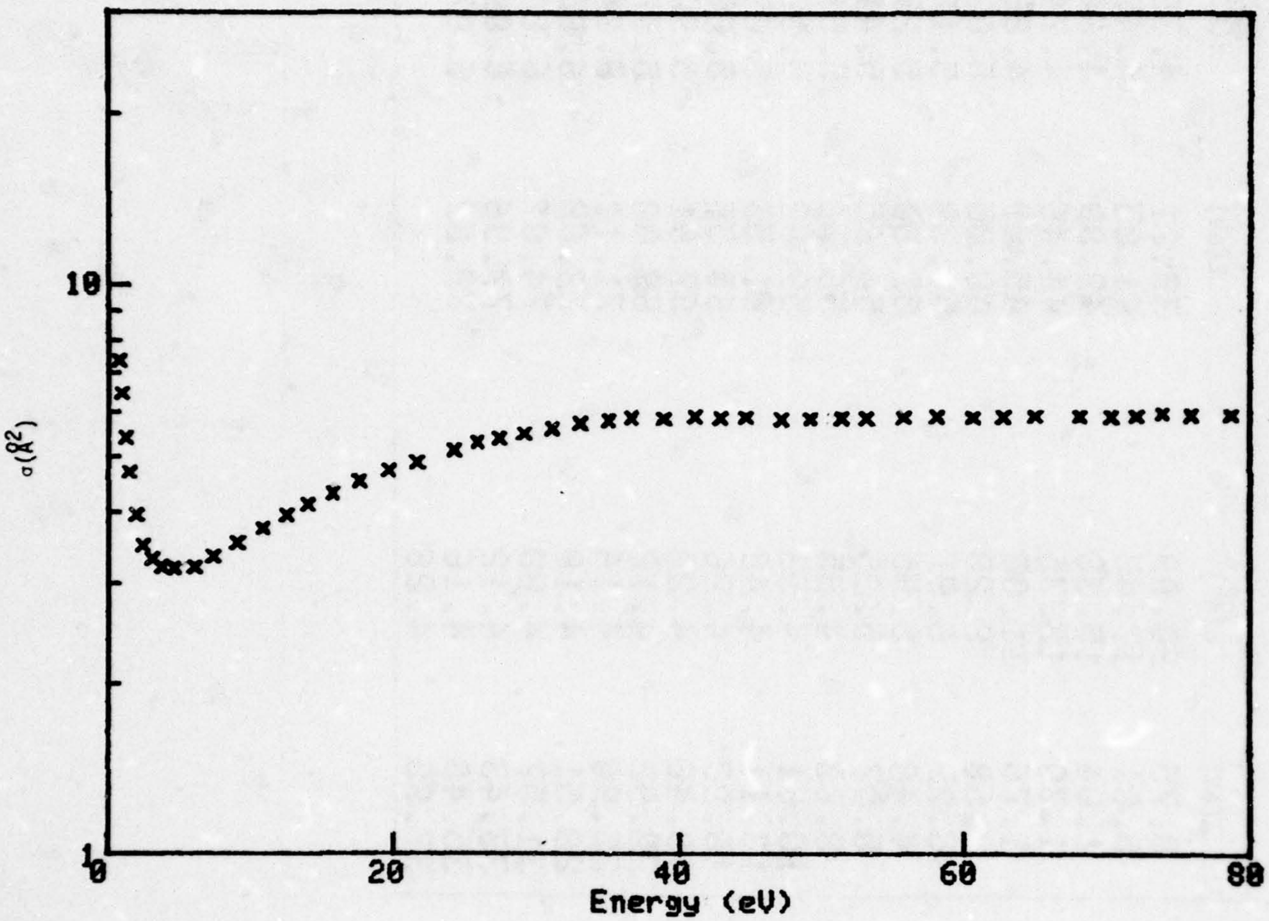
Graph 17 $Ne^{+} + Ar \rightarrow Ne + Ar^{+}$

Graphical Data B-1.62.

Tabular Data B-1.63.

Table 18 $Ne^{++} + Kr \rightarrow Ne^{+}$(Production)

E(eV)	σ(Å^2)	E(eV)	σ(Å^2)
0.71	7.38	31.14	5.62
0.97	6.45	33.08	5.73
1.23	5.40	35.05	5.79
1.49	4.70	36.62	5.87
1.95	3.96	38.90	5.86
2.46	3.49	41.17	5.89
3.08	3.32	42.92	5.87
3.73	3.21	44.69	5.88
4.63	3.18	47.22	5.83
6.06	3.21	49.21	5.85
7.36	3.34	51.38	5.87
9.04	3.54	53.15	5.87
10.78	3.75	55.79	5.88
12.44	3.96	58.10	5.90
13.98	4.13	60.60	5.89
15.72	4.32	62.76	5.91
17.63	4.54	64.98	5.91
19.65	4.74	68.10	5.92
21.62	4.90	70.30	5.91
24.23	5.16	72.09	5.91
25.86	5.32	73.89	5.97
27.40	5.41	75.86	5.93
29.15	5.51	78.64	5.95



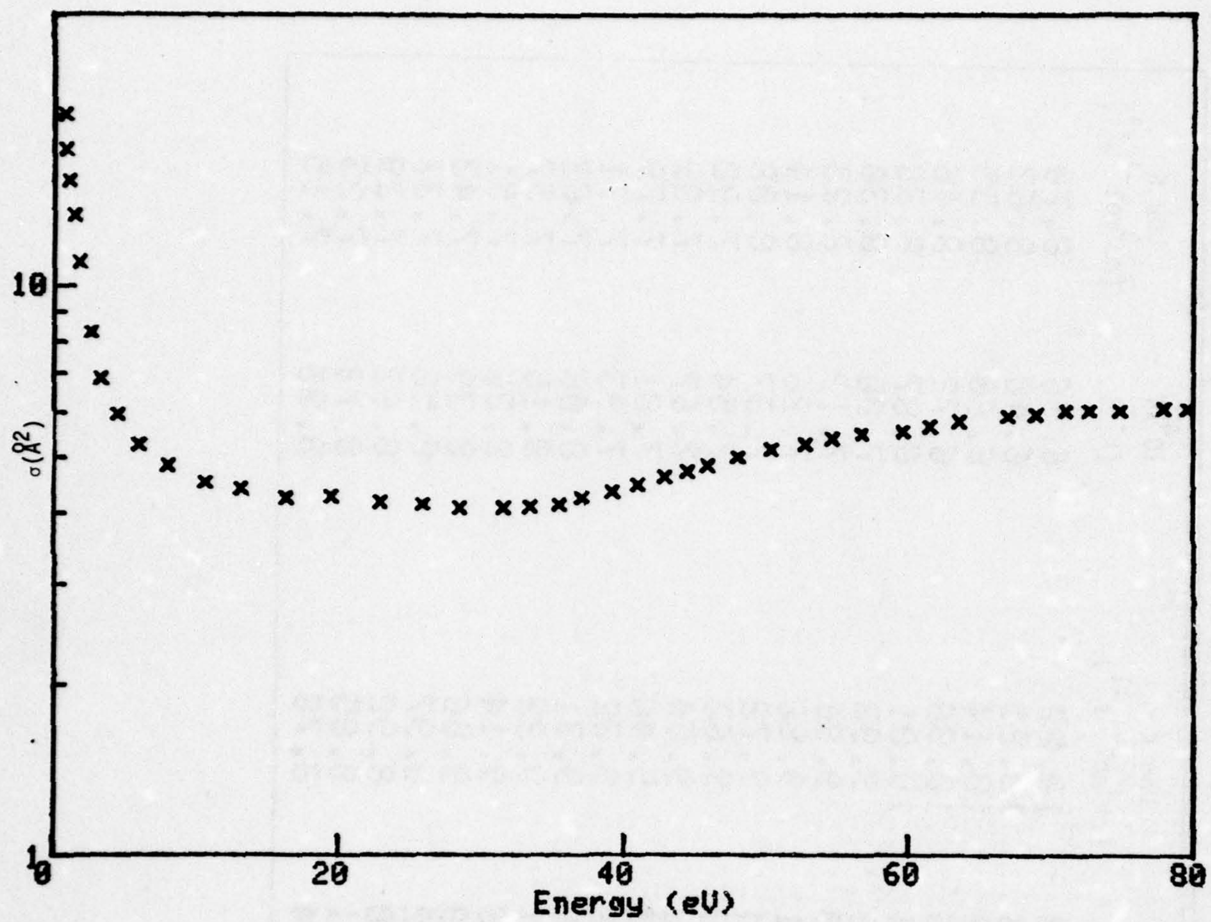
Graph 18 $Ne^{++} + Kr \rightarrow Ne^{+}$ (Production)

Graphical Data B-1.64.

Tabular Data B-1.65.

Table 19 $Ne^{++} + Kr \rightarrow Kr^{+}$(Production)

E(eV)	σ($Å^2$)	E(eV)	σ($Å^2$)
0.75	20.09	39.21	4.38
0.81	17.43	41.03	4.48
1.04	15.38	42.89	4.64
1.38	13.35	44.46	4.74
1.76	11.03	45.89	4.86
2.58	8.28	48.05	5.03
3.29	6.87	50.38	5.17
4.48	5.95	52.80	5.29
5.97	5.25	54.65	5.41
8.03	4.85	56.76	5.51
10.61	4.53	59.62	5.57
13.11	4.42	61.53	5.68
16.29	4.26	63.55	5.80
19.46	4.28	67.01	5.92
22.92	4.18	69.00	5.97
25.90	4.16	71.11	6.04
28.51	4.10	72.68	6.05
31.57	4.08	74.87	6.05
33.43	4.12	77.96	6.09
35.48	4.16	79.62	6.07
37.05	4.26		



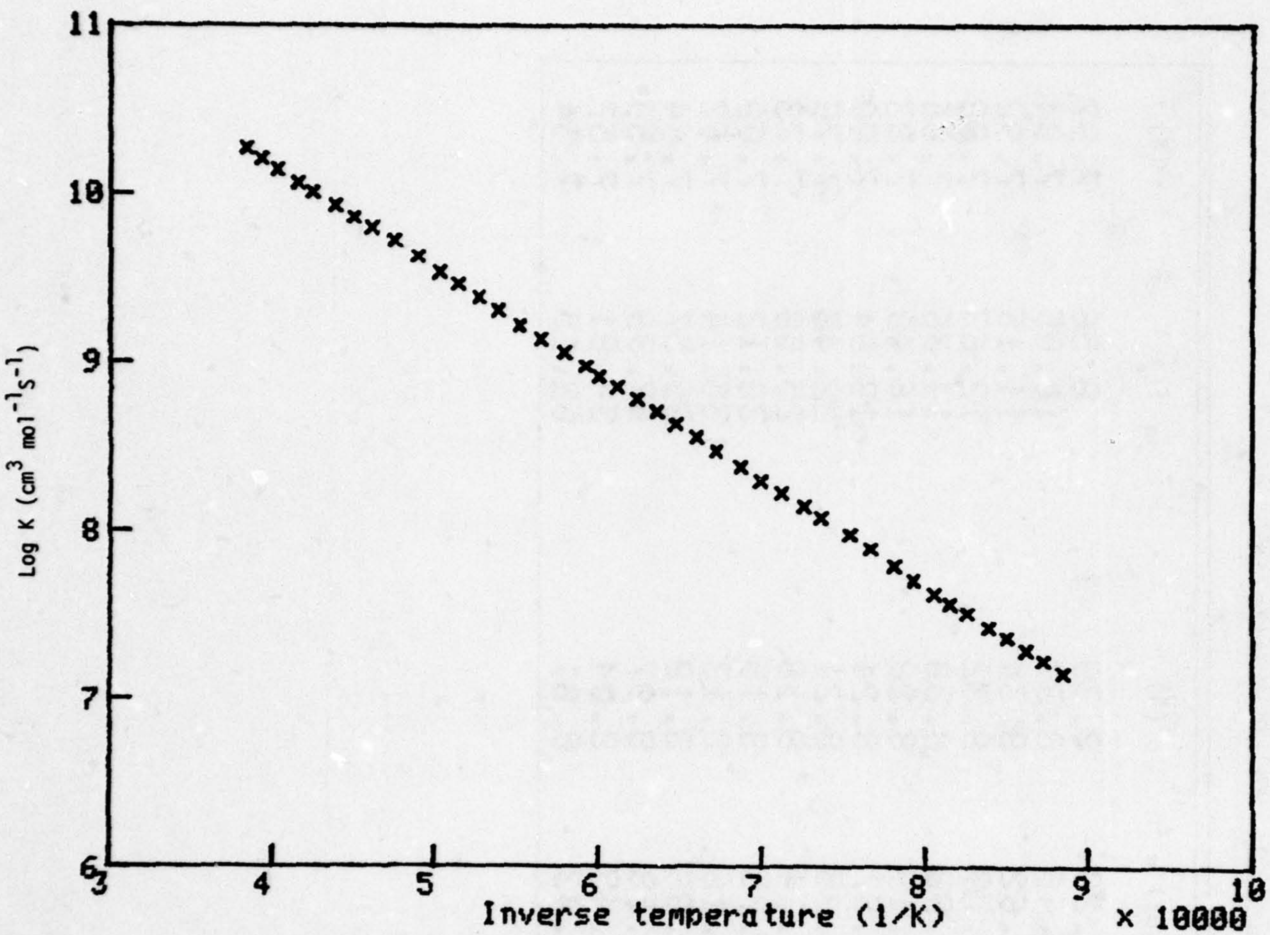
Graph 19 $Ne^{++} + Kr \rightarrow Kr^{+}$ (Production)

Graphical Data B-1.66.

Tabular Data B-1.67.

Table 20 $Ar+F_2 \rightarrow F+F+Ar$

$10^4/T$ (K^{-1})	Log K ($cm^3 mol^{-1} s^{-1}$)	$10^4/T$ (K^{-1})	Log K ($cm^3 mol^{-1} s^{-1}$)
3.83	10.27	6.36	8.70
3.93	10.21	6.48	8.63
4.02	10.14	6.60	8.55
4.15	10.06	6.72	8.48
4.24	10.01	6.87	8.38
4.38	9.93	7.00	8.30
4.50	9.86	7.12	8.23
4.61	9.80	7.26	8.14
4.74	9.72	7.37	8.08
4.88	9.63	7.54	7.98
5.02	9.54	7.67	7.89
5.13	9.46	7.81	7.79
5.26	9.38	7.93	7.71
5.38	9.31	8.06	7.63
5.51	9.22	8.15	7.57
5.65	9.14	8.26	7.51
5.79	9.06	8.39	7.43
5.92	8.97	8.50	7.37
6.00	8.92	8.62	7.29
6.11	8.85	8.73	7.23
6.24	8.78	8.85	7.15



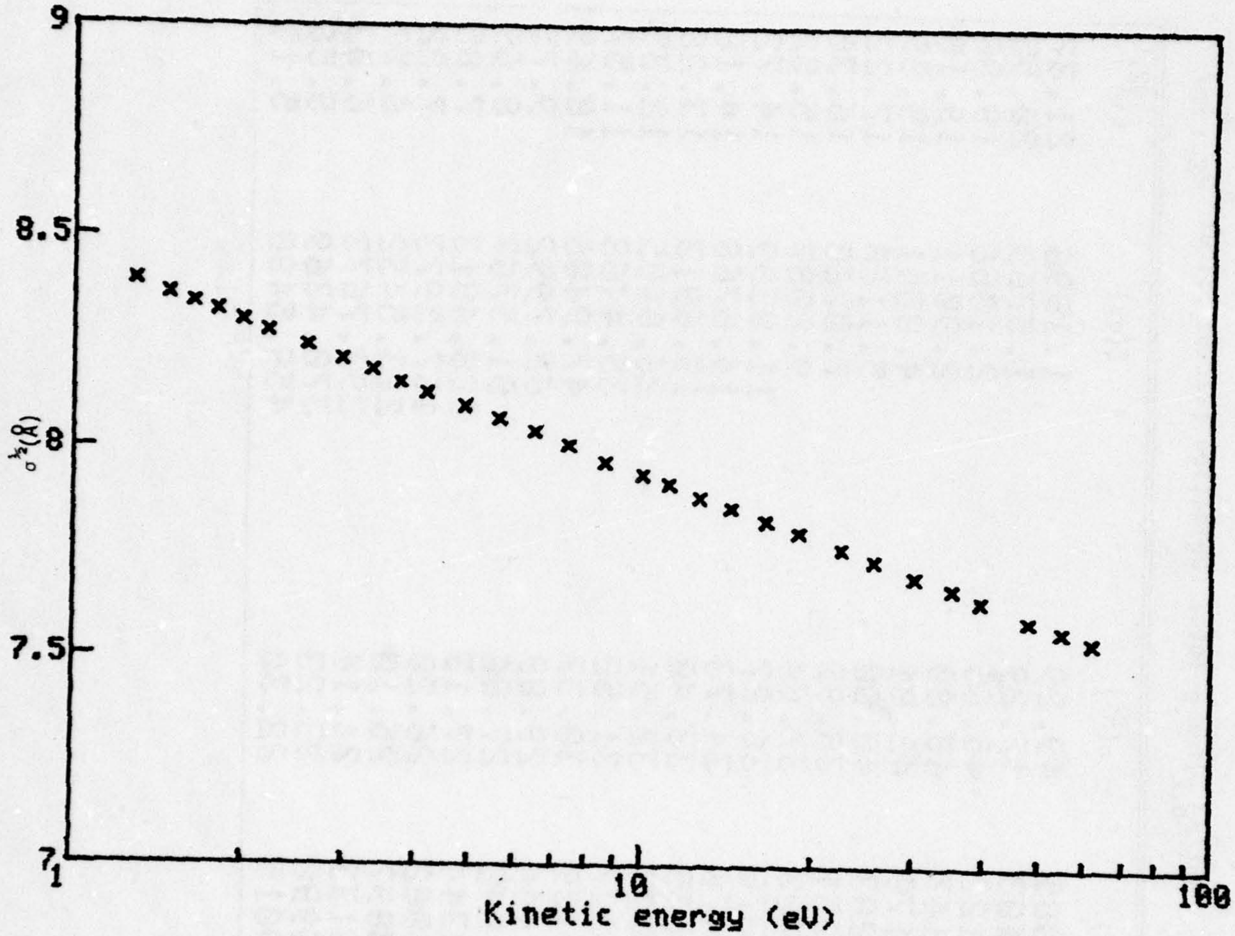
Graph 20 $Ar+F_2 \rightarrow F+F+Ar$

Graphical Data B-1.68.

Tabular Data B-1.69.

Table 21 $Xe^+ + Xe \rightarrow Xe + Xe^+$

E(eV)	$\sigma^{\frac{1}{2}}$(Å)	E(eV)	$\sigma^{\frac{1}{2}}$(Å)
1.28	8.39	8.56	7.97
1.46	8.37	10.05	7.94
1.62	8.34	11.15	7.92
1.79	8.32	12.63	7.88
1.98	8.30	14.36	7.86
2.19	8.28	16.48	7.83
2.57	8.24	18.84	7.80
2.95	8.21	22.43	7.76
3.34	8.18	25.58	7.73
3.75	8.15	30.12	7.69
4.16	8.13	35.14	7.67
4.86	8.10	39.57	7.64
5.58	8.07	47.99	7.59
6.45	8.04	54.81	7.57
7.43	8.01	62.15	7.54



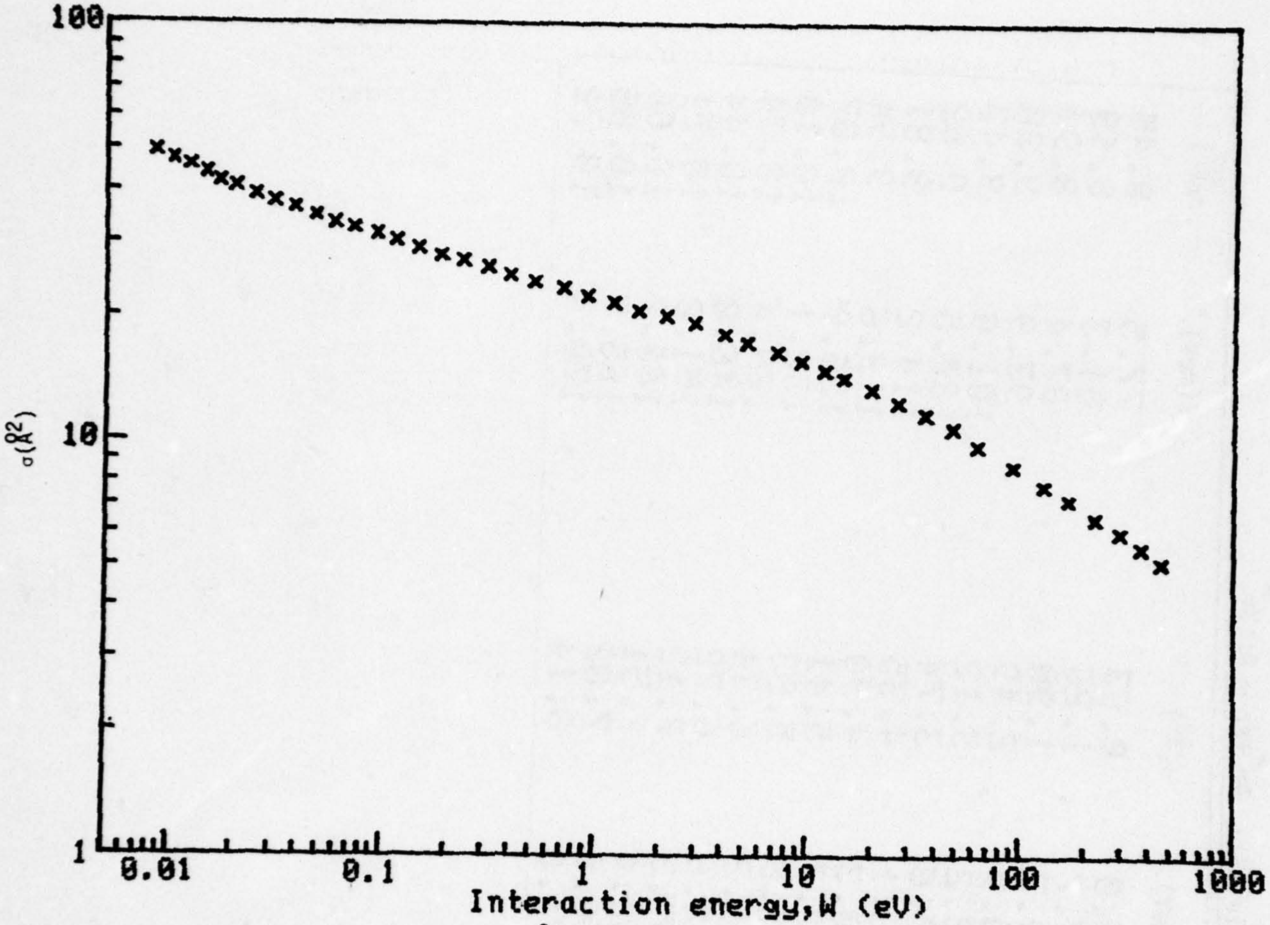
Graph 21 $Xe^{+}+Xe \rightarrow Xe+Xe^{+}$

Graphical Data B-1.70.

Tabular Data B-1.71.

Table 22 $Ne(^3P_{o,2})+Ar \rightarrow$ Total Ionization (Ratio: 5:1 of $^3P_2$ ^3P_o)

E(eV)	$\sigma(\AA^2)$	E(eV)	$\sigma(\AA^2)$
0.0085	49.29	1.1996	21.37
0.0103	47.29	1.5769	20.55
0.0122	45.65	2.1366	19.98
0.0147	43.80	2.9011	19.18
0.0170	42.01	4.0041	18.05
0.0203	40.80	5.1168	17.22
0.0251	38.99	7.0760	16.30
0.0303	37.64	9.2087	15.52
0.0378	36.27	11.8399	14.72
0.0476	34.73	14.6768	14.16
0.0585	33.40	19.6913	13.26
0.0724	32.51	26.0485	12.35
0.0927	31.52	35.4468	11.57
0.1139	30.37	47.9488	10.69
0.1444	29.09	62.7992	9.75
0.1845	27.86	91.5767	8.69
0.2344	27.13	128.4913	7.85
0.3062	26.20	167.5973	7.22
0.3897	25.10	223.5452	6.57
0.5133	24.14	292.7673	6.03
0.6998	23.23	370.4369	5.58
0.9015	22.30	456.5480	5.15



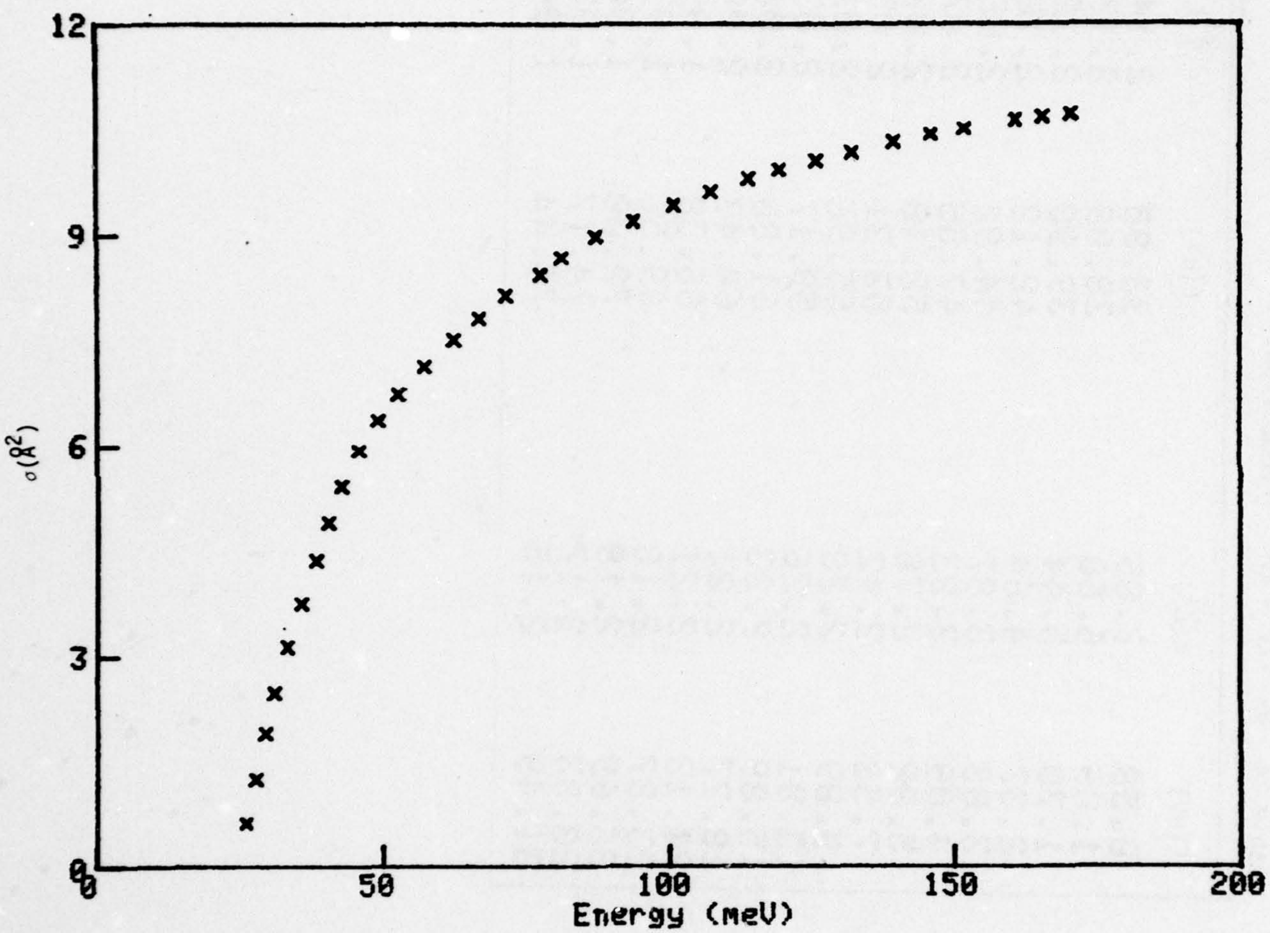
Graph 22 $Ne(^3P_{o,2})+Ar \rightarrow$ Total Ionization (Ratio: 5:1 of $^3P_2:^3P_o$)

Graphical Data B-1.72.

Tabular Data B-1.73.

Table 23 $Ar^{*}+Kr \rightarrow Ar+Kr^{*}$

E(meV)	σ(Å²)	E(meV)	σ(Å²)
26.0	0.63	77.5	8.45
27.7	1.26	81.3	8.69
29.3	1.90	87.4	8.99
30.9	2.49	93.9	9.20
33.2	3.12	101.0	9.43
35.6	3.74	107.5	9.62
38.1	4.35	114.2	9.81
40.3	4.90	119.6	9.94
42.7	5.41	126.0	10.07
45.9	5.93	132.1	10.18
49.2	6.34	139.4	10.34
52.6	6.72	146.0	10.44
57.3	7.12	151.8	10.51
62.4	7.51	160.7	10.64
66.8	7.82	165.5	10.68
71.6	8.14	170.4	10.72



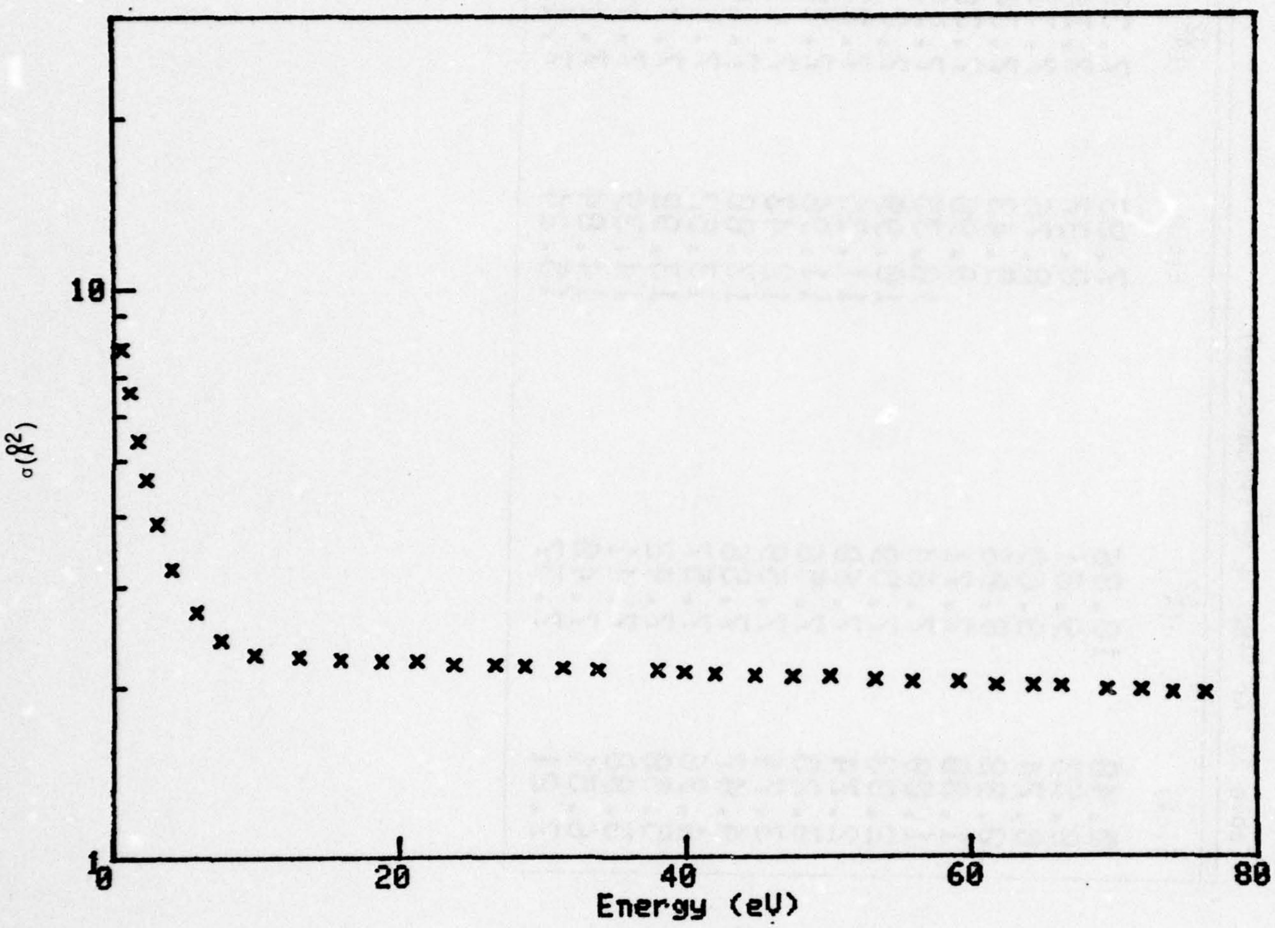
Graph 23 $Ar^* + Kr \rightarrow Ar + Kr^*$

Graphical Data B-1.74.

Tabular Data B-1.75.

Table 24 $Ne^{++} + Kr \rightarrow Kr^{++}$ (Production)

E(eV)	σ(Å^2)	E(eV)	σ(Å^2)
0.58	7.88	33.90	2.14
1.09	6.60	38.09	2.13
1.70	5.44	39.98	2.12
2.37	4.64	42.12	2.10
3.03	3.87	44.92	2.08
4.09	3.23	47.55	2.07
5.82	2.70	50.18	2.07
7.53	2.42	53.31	2.05
9.89	2.28	55.96	2.03
13.01	2.26	59.17	2.03
15.89	2.23	61.80	2.00
18.77	2.21	64.43	2.00
21.18	2.21	66.38	1.99
23.87	2.18	69.56	1.97
26.69	2.18	72.00	1.96
28.83	2.17	74.17	1.95
31.49	2.15	76.44	1.94



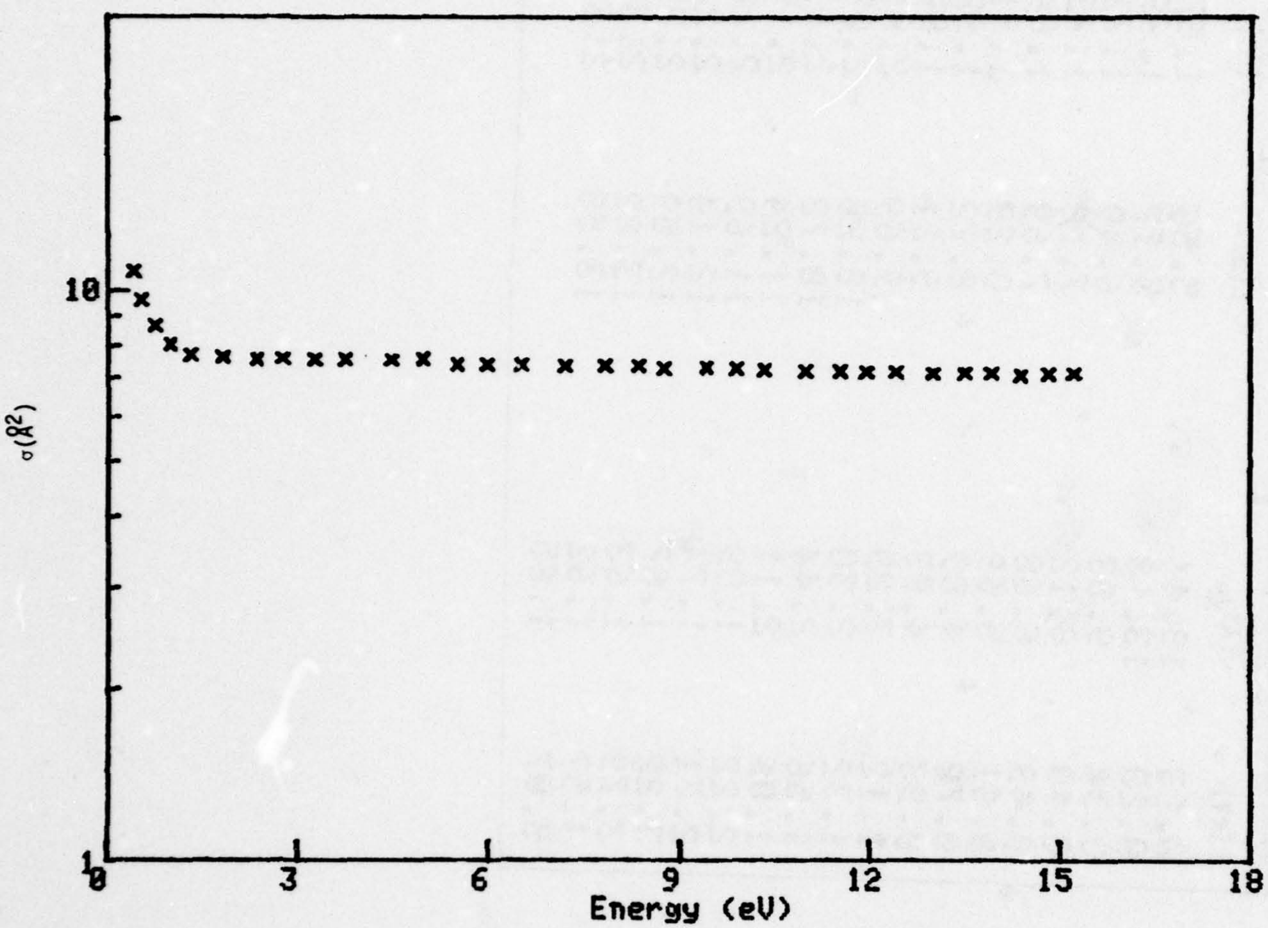
Graph 24 $Ne^{++} + Kr \rightarrow Kr^{++}$ (Production)

Graphical Data B-1.76.

Tabular Data B-1.77.

Table 25 $Kr^{++}+Ne \rightarrow Kr^{+}$(Production)

E(eV)	σ(Å^2)	E(eV)	σ(Å^2)
0.40	10.86	7.83	7.37
0.53	9.61	8.37	7.36
0.74	8.69	8.76	7.31
0.98	8.03	9.43	7.34
1.30	7.71	9.90	7.30
1.80	7.64	10.35	7.25
2.33	7.59	10.99	7.21
2.74	7.60	11.55	7.23
3.25	7.56	11.96	7.18
3.74	7.59	12.43	7.19
4.47	7.56	13.00	7.16
4.96	7.57	13.52	7.14
5.50	7.42	13.92	7.15
5.98	7.41	14.39	7.10
6.51	7.40	14.84	7.14
7.21	7.37	15.24	7.14



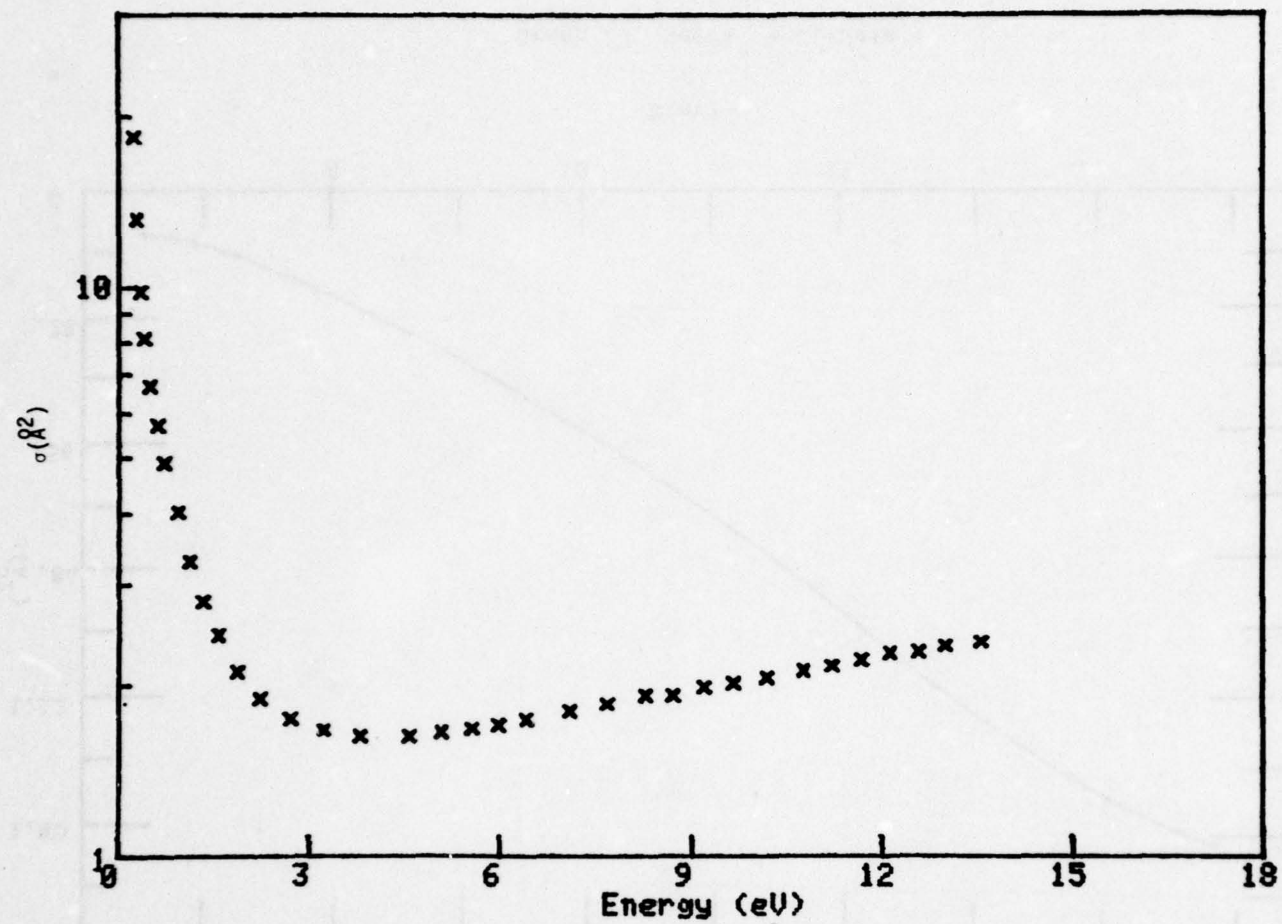
Graph 25 $Kr^{++} + Ne \rightarrow Kr^{+}$ (Production)

Graphical Data B-1.78.

Tabular Data B-1.79.

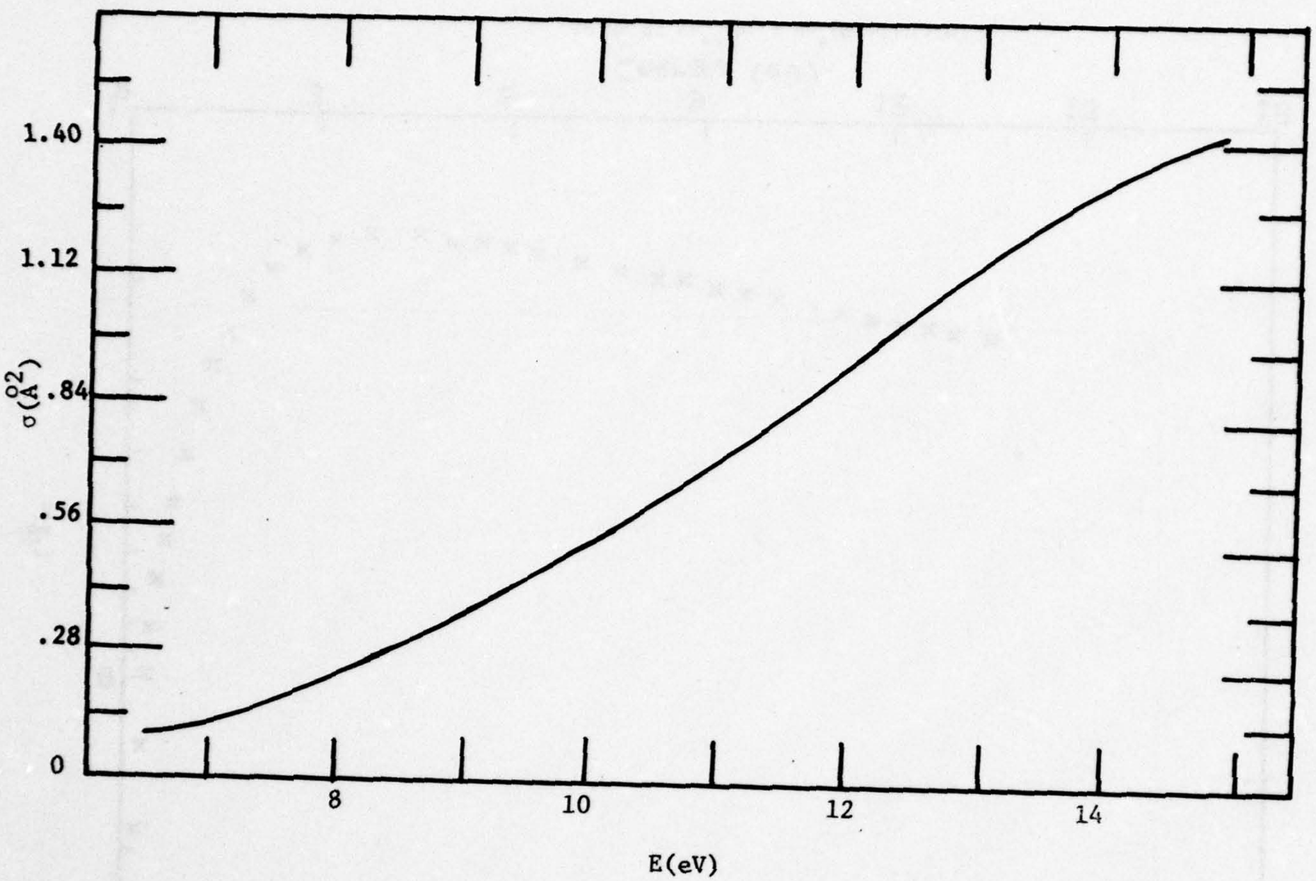
Table 26 $Kr^{++} + Ne \rightarrow Ne^{+}$ (Production)

E(eV)	σ(Å^2)	E(eV)	σ(Å^2)
0.23	18.44	5.56	1.67
0.28	13.18	5.97	1.69
0.34	9.83	6.40	1.73
0.40	8.12	7.10	1.79
0.49	6.68	7.69	1.84
0.61	5.69	8.29	1.91
0.72	4.89	8.72	1.92
0.93	4.03	9.21	1.97
1.12	3.29	9.69	2.01
1.32	2.80	10.20	2.05
1.56	2.44	10.78	2.11
1.86	2.11	11.24	2.15
2.22	1.89	11.69	2.20
2.71	1.74	12.14	2.26
3.22	1.67	12.59	2.27
3.79	1.63	13.02	2.33
4.57	1.62	13.58	2.37
5.07	1.65		



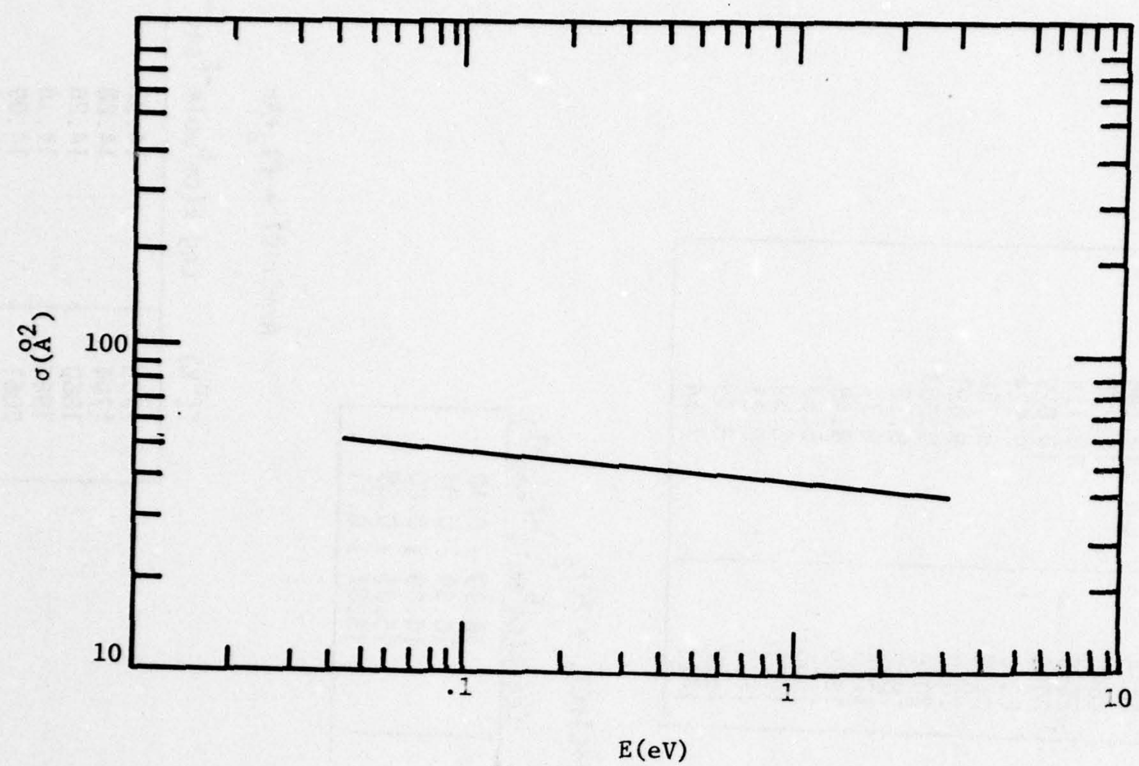
Graph 26 $Kr^{++} + Ne \rightarrow Ne^{+}$ (Production)

Graphical Data B-1.80.



Graph 27 $Ne + Cl^- \rightarrow Cl + Ne + e$

Graphical Data B-1.81.



$^{22}Ne^{+} + {}^{20}Ne \rightarrow {}^{22}Ne + {}^{20}Ne^{+}$

Graphical Data B-1.82.

Tabular Data B-1.83.

$Ne+F_2 \rightarrow F+F+Ne$

$T(^oK)$	$\text{Log } k(cm^3 mole^{-1} S^{-1})$
2670	10.146
2645	10.146
2645	10.230
2575	10.114
2460	10.079
2355	9.929
2145	9.756
2090	9.491
2040	9.663
1802	9.12
1770	8.77
1695	8.49
1653	8.63
1631	8.39
1567	8.21
1522	8.19
1422	7.84

$Cl+Cl+Cl_2 \rightarrow 2Cl_2$

$T(^oK)$	$\text{Log } k(cm^6 mole^{-2} sec^{-1})$
195	16.90 ± 0.10
298	16.30 ± 0.04
361	16.06 ± 0.05
474	15.85 ± 0.09
490	15.81 ± 0.11

$Ar+Cl+Cl \rightarrow Cl_2+Ar$

$T(^oK)$	$\text{Log } k(cm^6 mole^{-2} sec^{-1})$
1738	14.33
1794	14.28
1860	14.26
1964	14.16
2061	14.09
2217	14.08
2324	14.00
2475	13.99

Tabular Data B-1.84.

$Br_2(B^3\pi_{ou}^{+}) + Br_2 \rightarrow$ Quenching

Source of Excitation (Å)	States Excited v	Quenching Cross Section (Å^2)
6260	1,3,5	56 ± 16
6140	3,6,7	58 ± 8
6025	5,7,9	77 ± 4
5970	6,8,10	116 ± 21
5874	9,11,13	72 ± 7
5738	11,13,16	115 ± 11
5615	14,17,19	73 ± 7
5496	17,20,23	97 ± 46
5411	20,23,27	167 ± 40
5325	23,27,30	47 ± 13
5225	27,31	137 ± 13
5221	27 ∼ 31	81 ± 7
5131	31 ∼ 40	162 ± 35

$Br_2 + Br_2 \rightarrow 2Br + Br_2$

T(^{o}K)	k(cm^{3}mole^{-1}sec^{-1})
1010	1.7×10^7
1050	2.1×10^7
1100	1.8×10^7
1220	4.6×10^7
1240	9.7×10^7
1245	4.8×10^7
1320	1.5×10^8
1370	3.0×10^8
1390	4.5×10^8
1425	3.2×10^8
1445	2.9×10^8
1550	6.4×10^8
1610	1.3×10^9

Tabular Data B-1.85.

$Ar+Br_2 \rightarrow Br+Br+Ar$

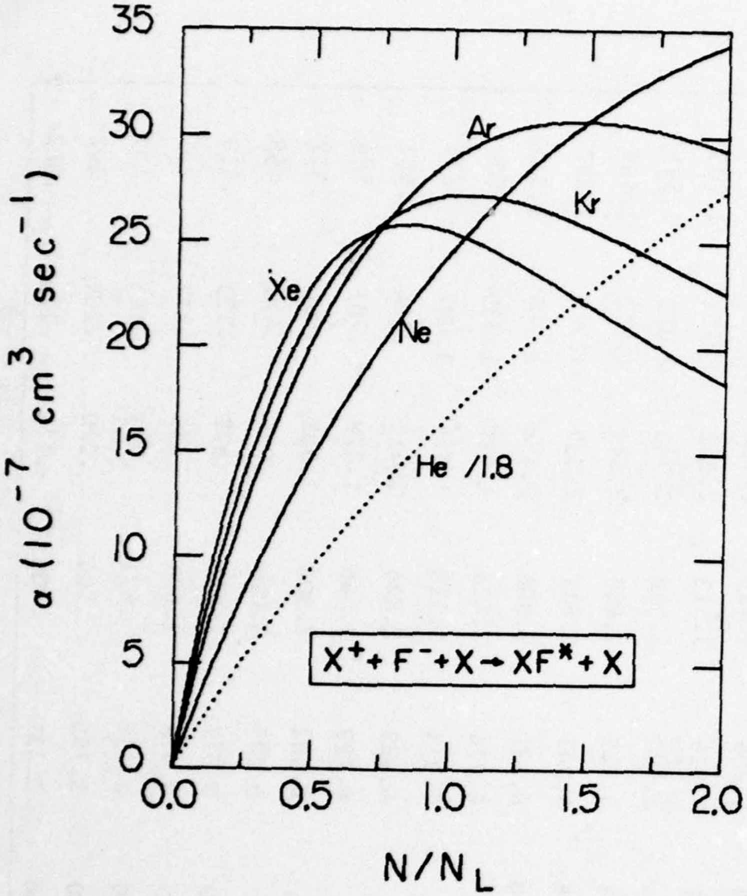
$T(^oK)$	$k(cm^3mole^{-1}sec^{-1})$
1310	$9.7x10^7$
1330	$8.1x10^7$
1380	$2.9x10^8$
1425	$9.7x10^7$
1520	$3.7x10^8$
1580	$5.0x10^8$
1750	$1.7x10^9$
1840	$1.3x10^9$
1840	$7.2x10^9$
1965	$5.3x10^9$
2050	$6.5x10^9$
2080	$6.5x10^9$
2225	$1.2x10^{10}$

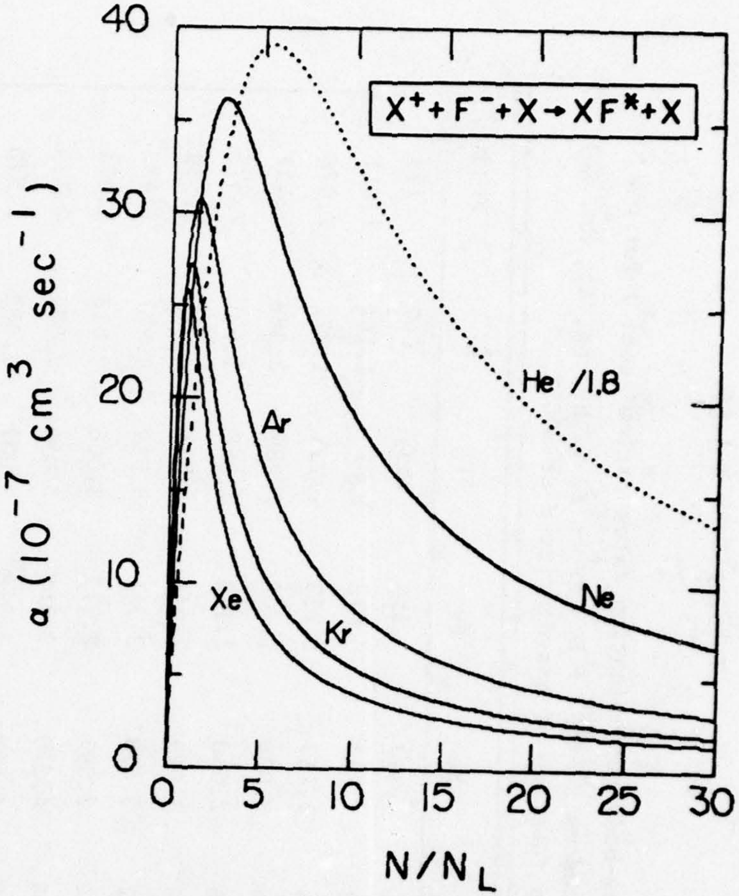
Tabular Data B-1.86.

Three-body recombination rates α ($cm^3\ sec^{-1}$) for the processes $X^+ + F^- + X \rightarrow XF^* + X$, ($X \equiv He, Ne, Ar, Kr, Xe$) as a function of gas-density N at 300 K.

N/N_L †	He	Ne	Ar	Kr	Xe (10^{-6})
0.1	.390	.354	.554	.647	.743
0.2	.753	.673	1.018	1.164	1.311
0.4	1.413	1.233	1.755	1.922	2.076
0.6	2.004	1.708	2.289	2.388	2.457
0.8	2.540	2.112	2.658	2.631	2.575
1.0	3.029	2.454	2.891	2.715	2.538
1.2	3.478	2.741	3.019	2.697	2.422
1.4	3.891	2.977	3.066	2.618	2.274
1.6	4.270	3.168	3.056	2.507	2.119
1.8	4.618	3.318	3.007	2.383	1.970
2.0	4.936	3.431	2.932	2.255	1.831
2.2	5.226	3.513	2.842	2.131	1.705
2.4	5.490	3.568	2.743	2.013	1.591
2.6	5.727	3.599	2.641	1.902	1.489
2.8	5.941	3.611	2.539	1.799	1.397
3.0	6.131	3.606	2.438	1.705	1.315
4	6.774	3.424	1.996	1.335	1.009
5	7.015	3.128	1.664	1.087	.814
6	6.989	2.824	1.416	.914	.681
7	6.799	2.546	1.228	.787	.584
8	6.522	2.303	1.082	.690	.512
9	6.205	2.094	.966	.614	.455
10	5.877	1.915	.872	.553	.410
20	3.478	1.001	.439	.277	.205
30	2.378	.671	.293	.185	.137
40	1.795	.504	.220	.139	.102
50	1.439	.403	.176	.111	.082

† N_L is Loschmidt's number ($2.60 \times 10^{19}\ cm^{-3}$)





$X^+ + F^- + X \quad XF^* + X \qquad$ X= Noble gas

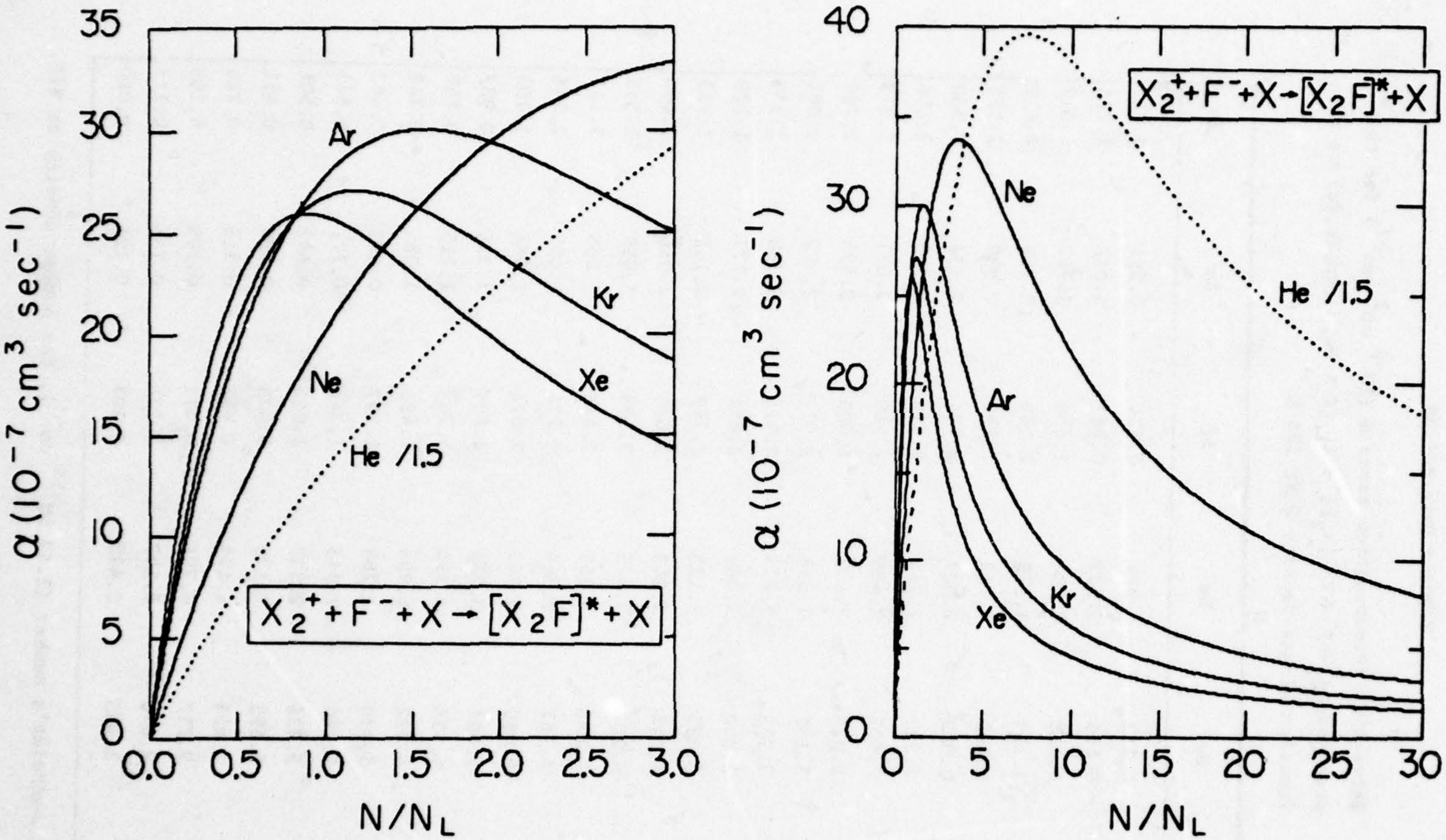
Graphical Data B-1.87.

Tabular Data B-1.88.

Three-body recombination rates α (10^{-6} cm^3 sec^{-1}) for the processes $X_2^+ + F^- + X \rightarrow [X_2F]^* + X$, ($X \equiv$ He,Ne,Ar,Kr,Xe) as a function of gas-density N at 300 K

N/N_L [a]	He	Ne	Ar	Kr	Xe
0.1	0.251	0.279	0.524	0.591	0.711
0.2	0.486	0.533	0.962	1.068	1.258
0.4	0.918	0.984	1.658	1.787	2.012
0.6	1.309	1.373	2.169	2.259	2.419
0.8	1.669	1.712	2.532	2.539	2.578
1.0	2.002	2.007	2.774	2.674	2.580
1.2	2.312	2.264	2.919	2.706	2.496
1.4	2.602	2.486	2.989	2.671	2.370
1.6	2.875	2.677	3.003	2.595	2.230
1.8	3.131	2.838	2.977	2.497	2.088
2.0	3.373	2.973	2.924	2.388	1.953
2.2	3.600	3.084	2.852	2.277	1.828
2.4	3.813	3.173	2.769	2.166	1.713
2.6	4.014	3.243	2.680	2.060	1.608
2.8	4.202	3.295	2.588	1.959	1.513
3.0	4.378	3.332	2.496	1.865	1.427
3.5	4.767	3.369	2.274	1.655	1.246
4.0	5.090	3.347	2.074	1.481	1.103
4.5	5.351	3.285	1.897	1.336	0.987
5	5.556	3.198	1.743	1.215	0.892
6	5.822	2.986	1.491	1.025	0.748
7	5.930	2.760	1.297	0.885	0.643
8	5.924	2.545	1.146	0.777	0.563
9	5.836	2.347	1.024	0.692	0.501
10	5.695	2.170	0.925	0.624	0.451
20	3.854	1.179	0.467	0.313	0.226
30	2.717	0.794	0.311	0.209	0.105
40	2.070	0.597	0.234	0.156	0.113
50	1.665	0.478	0.187	0.125	0.090

[a] N_L is Loschmidt's number (2.69 10^{-19} cm^{-3}), the number density at STP.



$X_2^+ + F^- + X \quad [X_2F]^* + X \quad$ X= Noble Gas

Graphical Data B-1.89.

B-1

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B-2. HIGH ENERGY HEAVY PARTICLE-HEAVY PARTICLE COLLISIONS

General References

C.F. Barnett, J.A. Ray, E. Ricci, I. Wilker, E.W. McDaniel, E.W. Thomas and H.B. Gilbody, "Atomic Data for Controlled Fusion Research," Controlled Fusion Atomic Data Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Report ORNL 5206. (Feb., 1977).

R.C. Dehmel, H.K. Chan, and H.H. Fleishmann, Atomic Data 5, 231 (1973).

L.W. Muller and F.J. DeHeer Physica 48, 345 (1970).

E.W. Thomas, Excitation in Heavy Particle Collisions, (Wiley, New York, 1972).

B-2. HIGH ENERGY HEAVY PARTICLE-HEAVY PARTICLE COLLISIONS

CONTENTS

H^n, He^m/He, Ne, Ar Collisions

Tables and the corresponding graphs for hydrogen and helium ions and atoms incident on helium, neon, and argon

Tabular Data B-2.1.

Excitation Cross Sections for the Reactions

$$H^{o} + He \rightarrow H^{o} + He\ (4^1S,\ 4^1P,\ 4^3S,\ 4^3P)$$

Energy (keV)	Cross Sections for Excited States nℓ (cm^2)			
	4^1S	4^1P	4^3S	4^3P
1.0 E 01	1.30 E-19	2.60 E-20	1.50 E-19	3.64 E-19
1.5 E 01	1.63 E-19	7.90 E-20	3.32 E-19	4.71 E-19
2.0 E 01	1.85 E-19	1.25 E-19	4.07 E-19	3.68 E-19
2.5 E 01	1.96 E-19	1.47 E-19	3.88 E-19	2.50 E-19
3.0 E 01	1.82 E-19	1.86 E-19	3.43 E-19	1.71 E-19
3.5 E 01	1.58 E-19	2.12 E-19	3.13 E-19	1.25 E-19

References:

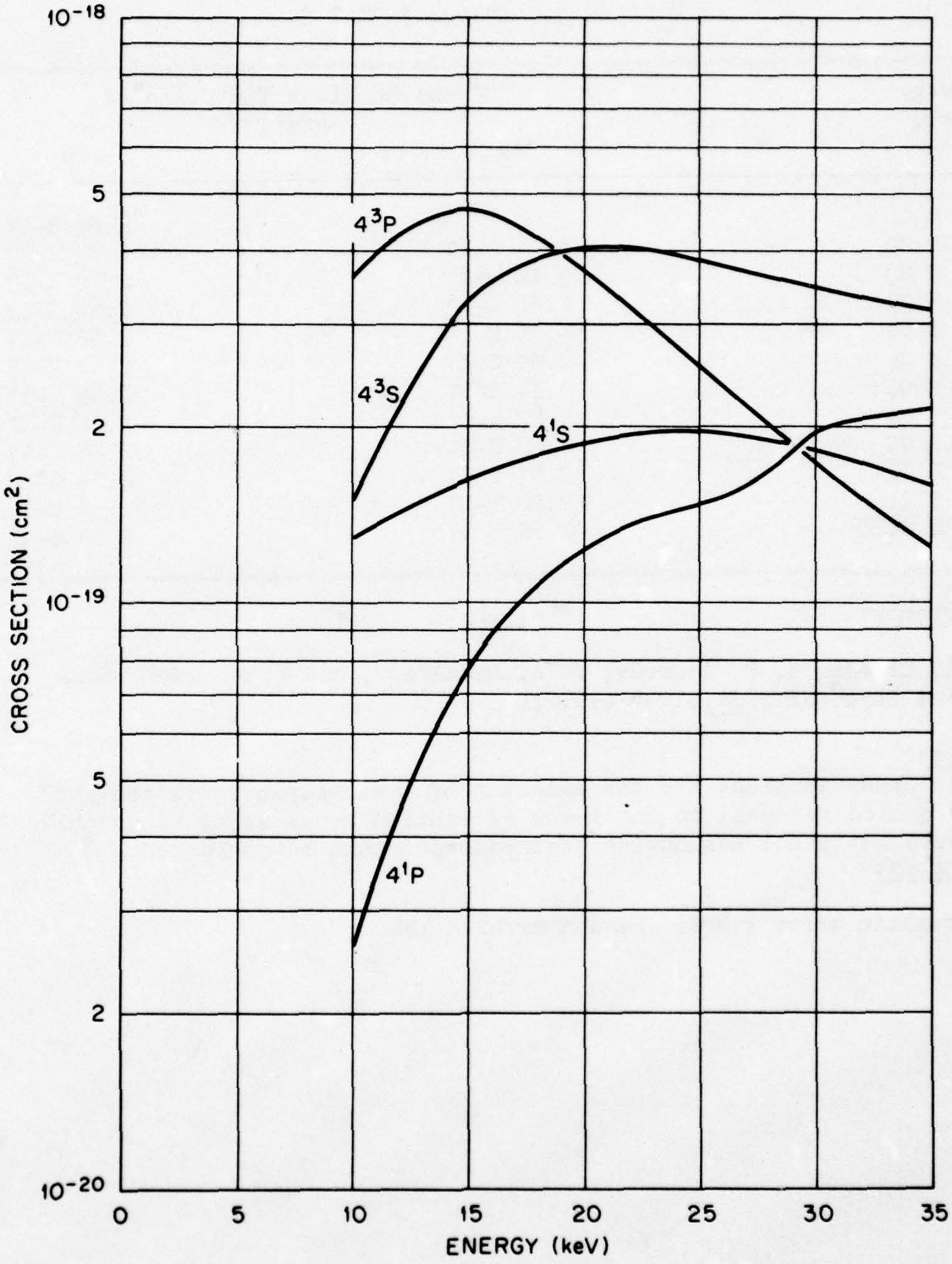
J. Van Eck, F. J. de Heer, and J. Kistemaker, Physica 30, 1171 (1964), as revised by J. Van den Bos;(private communication from F. J. de Heer).

Notes:

Some data above 75 keV impact energy have been taken for D^+ impact. These indicate that D^+ behaves the same as H^+ ions of the same energy.

Excitation Cross Sections for the Reactions

$H^{o} + He \rightarrow H^{o} + He\ (4^{1}S,\ 4^{1}P,\ 4^{3}S,\ 4^{3}P)$



Graphical Data B-2.2.

Tabular Data B-2.3.

Excitation Cross Sections for Reactions

$H^- + He \rightarrow H(2s,2p) + He + e$

Energy (keV)	Cross Sections for State nℓ (cm^2) 2p	2s
5.0 E 00		2.80 E-17
6.0 E 00	5.44 E-17	2.74 E-17
7.0 E 00	5.12 E-17	2.68 E-17
8.0 E 00	4.80 E-17	2.64 E-17
9.0 E 00	4.36 E-17	2.62 E-17
1.0 E 01	4.00 E-17	2.57 E-17
1.5 E 01	3.14 E-17	2.45 E-17
2.0 E 01	2.87 E-17	2.36 E-17
2.5 E 01	2.68 E-17	2.28 E-17
3.0 E 01	2.57 E-17	2.24 E-17
3.5 E 01	2.52 E-17	2.16 E-17
3.8 E 01	2.52 E-17	2.14 E-17

Reference:

A. L. Orbeli, E. P. Andreev, V. A. Ankudinov, and V. M. Dukel'ski, Soviet Phys.-JETP 31, 1044 (1970).

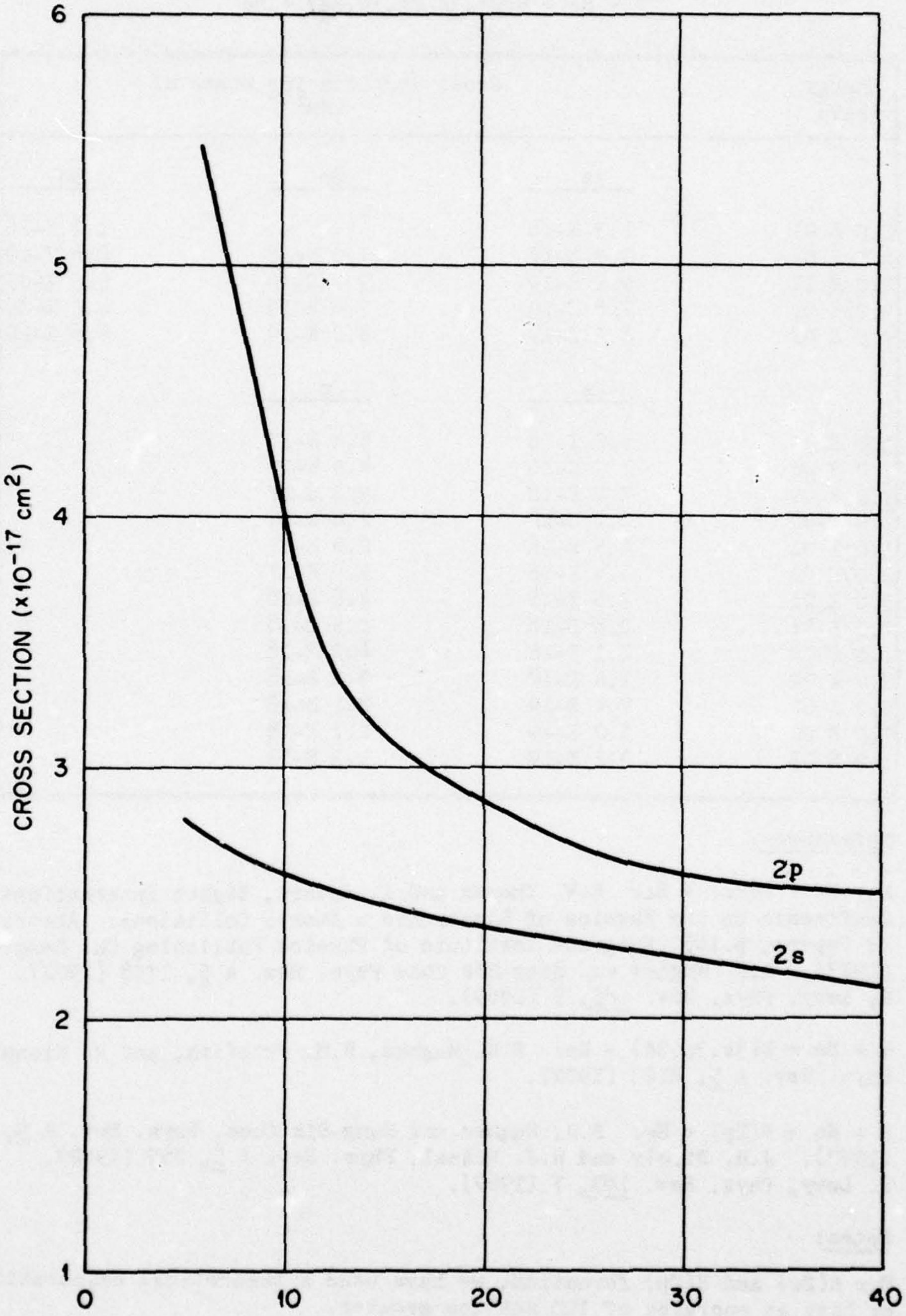
Notes:
These cross sections are for emission of Lyman-alpha radiation and were quoted as equal to the level excitation cross sections on the (unsubstantiated) assumption that cascade could be neglected.

Accuracy:

Systematic error < 40%. Random error < 15%.

Excitation Cross Sections for Reactions

$H^- + He \rightarrow H(2s,2p) + He + e$



Graphical Data B-2.4.

Tabular Data B-2.5.

Excitation Cross Sections for the Reactions

$H + He \rightarrow H(2s,3s,2p,3p,3d) + He$

Energy (keV)	Cross Sections for State $n\ell$ (cm^2)		
	3s	3p	3d
1.0 E 01	1.3 E-18		1.2 E-18
1.5 E 01	1.0 E-18	1.0 E-18	8.8 E-19
2.0 E 01	9.2 E-19	9.7 E-19	5.5 E-19
3.0 E 01	7.8 E-19	7.8 E-19	4.2 E-19
3.5 E 01	8.2 E-19	8.0 E-19	4.6 E-19
	2s	2p	
1.0 E 00	5.2 E-18	5.4 E-17	
2.0 E 00	7.3 E-18	4.6 E-17	
5.0 E 00	7.7 E-18	3.3 E-17	
7.0 E 00	7.0 E-18	2.6 E-17	
1.0 E 01	5.5 E-18	2.0 E-17	
2.0 E 01	4.4 E-18	1.0 E-17	
5.0 E 01	3.5 E-18	4.8 E-18	
7.0 E 01	2.8 E-18	4.5 E-18	
1.0 E 02	2.1 E-18	4.3 E-18	
2.0 E 02	1.4 E-18	3.2 E-18	
5.0 E 02	7.4 E-19	2.1 E-18	
7.0 E 02	5.2 E-19	1.7 E-18	
1.0 E 03	3.7 E-19	1.3 E-18	

References:

$H + He \rightarrow H(2s) + He$: E.W. Thomas and I. Sauers, Eighth International Conference on the Physics of Electronic & Atomic Collisions: Abstract of Papers, p.166, Beograde Institute of Physics Publishing Co. Beograd (1973). R.H. Hughes and Song-Sik Choe Phys. Rev. A 5, 1758 (1972). H. Levy, Phys. Rev. 185, 7 (1969).

$H + He \rightarrow H(3s,3p,3d) + He$: R.H. Hughes, H.M. Petefish, and H. Kisner, Phys. Rev. A 5, 2103 (1972).

$H + He \rightarrow H(2p) + He$: R.H. Hughes and Song-Sik Choe, Phys. Rev. A 5, 656 (1972). J.H. Birely and R.J. McNeal, Phys. Rev. A 5, 257 (1972). H. Levy, Phys. Rev. 185, 7 (1969).

Notes:

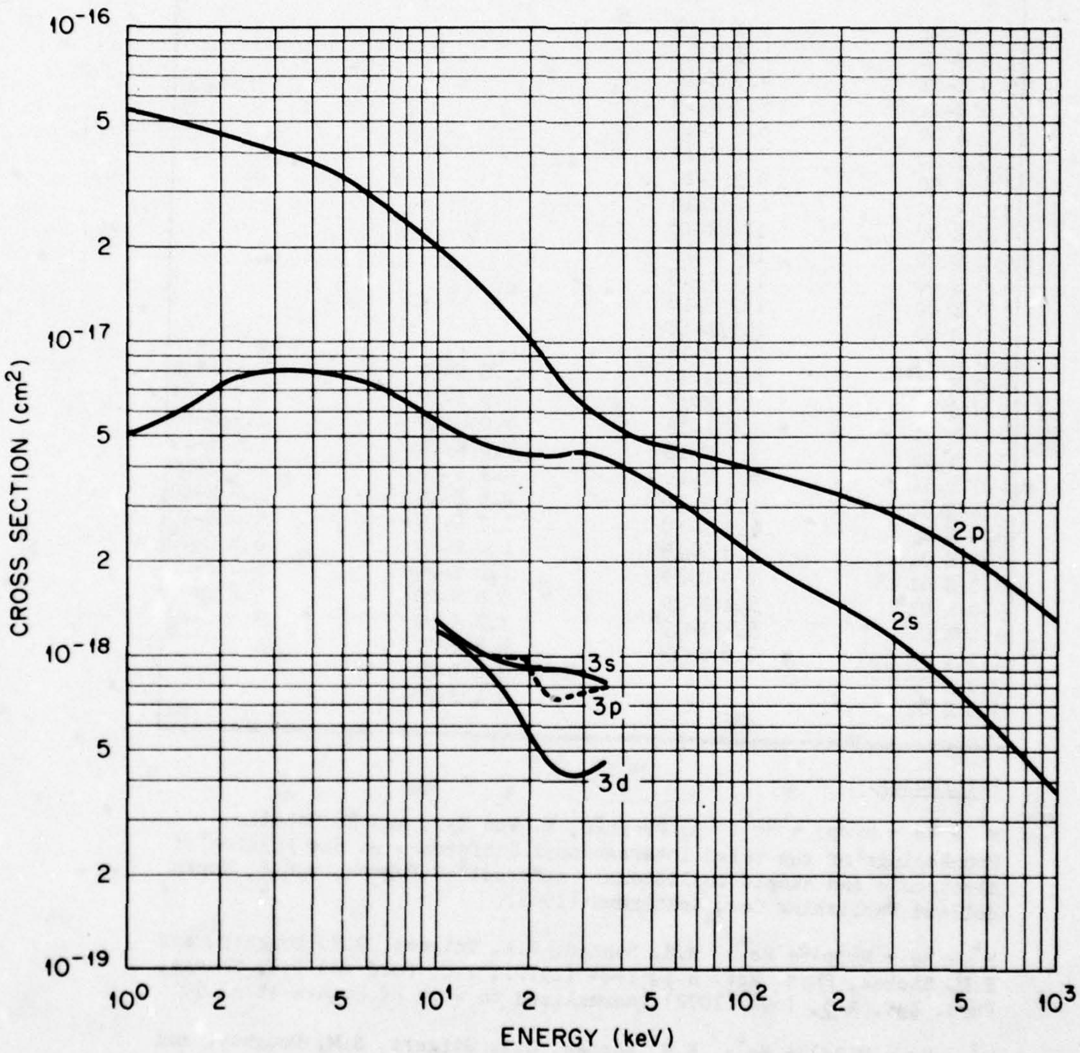
For H(2s) and H(2p) formation, we have used a theoretical calculation by Levy at energies of 100 keV and greater.

Accuracy:

Systematic error < 50%. Random error < 10%.

Excitation Cross Sections for the Reactions

H + He → H(2s,3s,2p,3p,3d) + He



Graphical Data B-2.6.

Tabular Data B-2.7.

Excitation Cross Sections by Electron Capture for the Reactions

$H^+ + He \rightarrow H(2p,3p,3d) + He^+$

Energy (keV)	Cross Sections for Excited State $n\ell$ (cm^2)		
	2p	3p	3d
2.5 E-01	4.7 E-19		
3.0 E-01	4.6 E-19		
5.0 E-01	4.8 E-19		
7.0 E-01	5.2 E-19		
1.0 E 00	6.2 E-19		
1.5 E 00	7.8 E-19		
2.0 E 00	9.3 E-19		
3.0 E 00	1.2 E-18		
4.0 E 00	1.4 E-18		
5.0 E 00	1.6 E-18		
6.0 E 00	1.7 E-18		
7.0 E 00	1.9 E-18		
8.0 E 00	2.1 E-18		
9.0 E 00	2.2 E-18		
1.0 E 01	2.4 E-18	3.6 E-19	1.3 E-19
1.5 E 01	3.2 E-18	4.5 E-19	1.9 E-19
2.0 E 01	3.6 E-18	6.0 E-19	1.9 E-19
3.0 E 01	3.3 E-18	7.0 E-19	1.6 E-19
4.0 E 01	2.5 E-18	4.7 E-19	1.2 E-19
5.0 E 01	1.7 E-18	2.6 E-19	1.0 E-19
6.0 E 01	1.3 E-18	1.7 E-19	8.0 E-20
7.0 E 01	1.0 E-18	1.0 E-19	6.5 E-20
8.0 E 01	7.9 E-19	7.0 E-20	5.2 E-20
9.0 E 01	6.4 E-19	5.0 E-20	4.2 E-20
1.0 E 02	5.4 E-19	3.7 E-20	3.7 E-20
1.5 E 02	2.8 E-19	9.4 E-21	
2.0 E 02		3.0 E-21	
3.0 E 02		3.4 E-22	

References:

$H^+ + He \rightarrow H(2p) + He^+$: D. Pretzer, B. Van Zyl, and R. Geballe, Proceedings of the Third International Conference on the Physics of Electronic and Atomic Collisions: Abstract of Papers, p.618, North Holland Publishing Co., Amsterdam (1963).

$H^+ + He \rightarrow H(3p) + He^+$: R.H. Hughes, C.A. Stigers, B.M. Doughty, and E.D. Stokes, Phys. Rev. A 1, 1424 (1970); J.C. Ford and E.W. Thomas, Phys. Rev. A 5, 1694 (1972) (normalized to work of Hughes et al.).

$H^+ + He \rightarrow H(3d) + He^+$: R.H. Hughes, C.A. Stigers, B.M. Doughty, and E.D. Stokes, Phys. Rev. A 1, 1424 (1970).

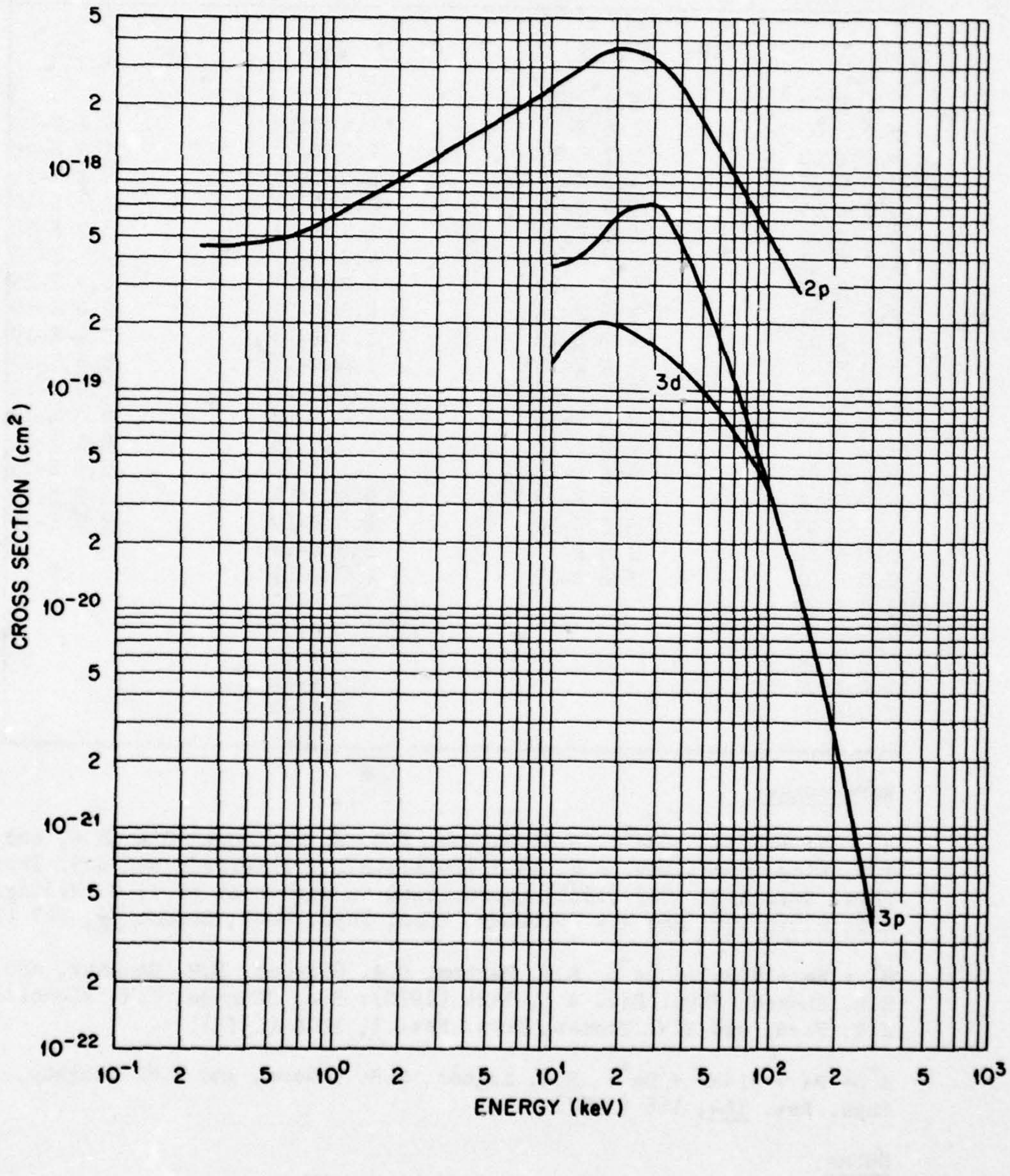
Notes:
In all cases these cross sections have been deduced on the (unsubstantiated) assumption that cascade into the relevant levels can be neglected.

Accuracy:

Systematic error < 50%. Random error < 15%.

Excitation Cross Sections by Electron Capture for the Reactions

$H^+ + He \rightarrow H(2p,3p,3d) + He^+$



Graphical Data B-2.8.

Tabular Data B-2.9.

Excitation Cross Sections by Electron Capture for the Reactions

$H^+ + He \rightarrow H(2s,3s,4s) + He^+$

Energy (keV)	Cross Sections for Excited State $n\ell$ (cm^2)		
	2s	3s	4s
4.0 E 00	6.5 E-20		
5.0 E 00	1.5 E-19	1.6 E-19	4.1 E-20
6.0 E 00	2.7 E-19	2.3 E-19	5.0 E-20
7.0 E 00	4.2 E-19	2.8 E-19	6.1 E-20
8.0 E 00	5.4 E-19	3.3 E-19	7.2 E-20
9.0 E 00	6.1 E-19	3.7 E-19	8.3 E-20
1.0 E 01	6.7 E-19	4.0 E-19	9.3 E-20
1.5 E 01	9.2 E-19	6.2 E-19	1.4 E-19
2.0 E 01	1.6 E-18	8.0 E-19	2.0 E-19
3.0 E 01	4.7 E-18	1.4 E-18	3.4 E-19
4.0 E 01	7.4 E-18	1.8 E-18	5.6 E-19
5.0 E 01	8.0 E-18	1.7 E-18	7.0 E-19
6.0 E 01	7.0 E-18	1.4 E-18	6.8 E-19
7.0 E 01	6.0 E-18	1.2 E-18	6.1 E-19
8.0 E 01	4.8 E-18	1.1 E-18	5.0 E-19
9.0 E 01	4.0 E-18	9.0 E-19	3.9 E-19
1.0 E 02	3.2 E-18	8.0 E-19	3.0 E-19
1.5 E 02	1.3 E-18	3.8 E-19	
2.0 E 02	5.6 E-19	1.6 E-19	
3.0 E 02		3.5 E-20	
4.0 E 02		1.0 E-20	
5.0 E 02		5.4 E-21	
6.0 E 02		3.0 E-21	
7.0 E 02		1.9 E-21	

References:

$H^+ + He \rightarrow H(2s) + He^+$: R.H. Hughes, E.D. Stokes, Song-Sik Choe, and T.J. King, Phys. Rev. A 4, 1453 (1971); R.L. Fitzwilson and E.W. Thomas, Phys. Rev. A 3, 1305 (1971) (normalized to Hughes et al.); G. Ryding, A.B. Wittkower, and H.B. Gilbody, Proc. Phys. Soc., London 89, 547 (1966).

$H^+ + He \rightarrow H(3s) + He^+$: R.H. Hughes, C.A. Stigers, B.M. Doughty, and E.D. Stokes, Phys. Rev. A 1, 1424 (1970); R.J. Conrads, T.W. Nichols, J.C. Ford, and E.W. Thomas, Phys. Rev. 7, 1928 (1973).

$H^+ + He \rightarrow H(4s) + He^+$: R.H. Hughes, H.R. Dawson, and B.M. Doughty, Phys. Rev. 164, 166 (1967).

Notes:

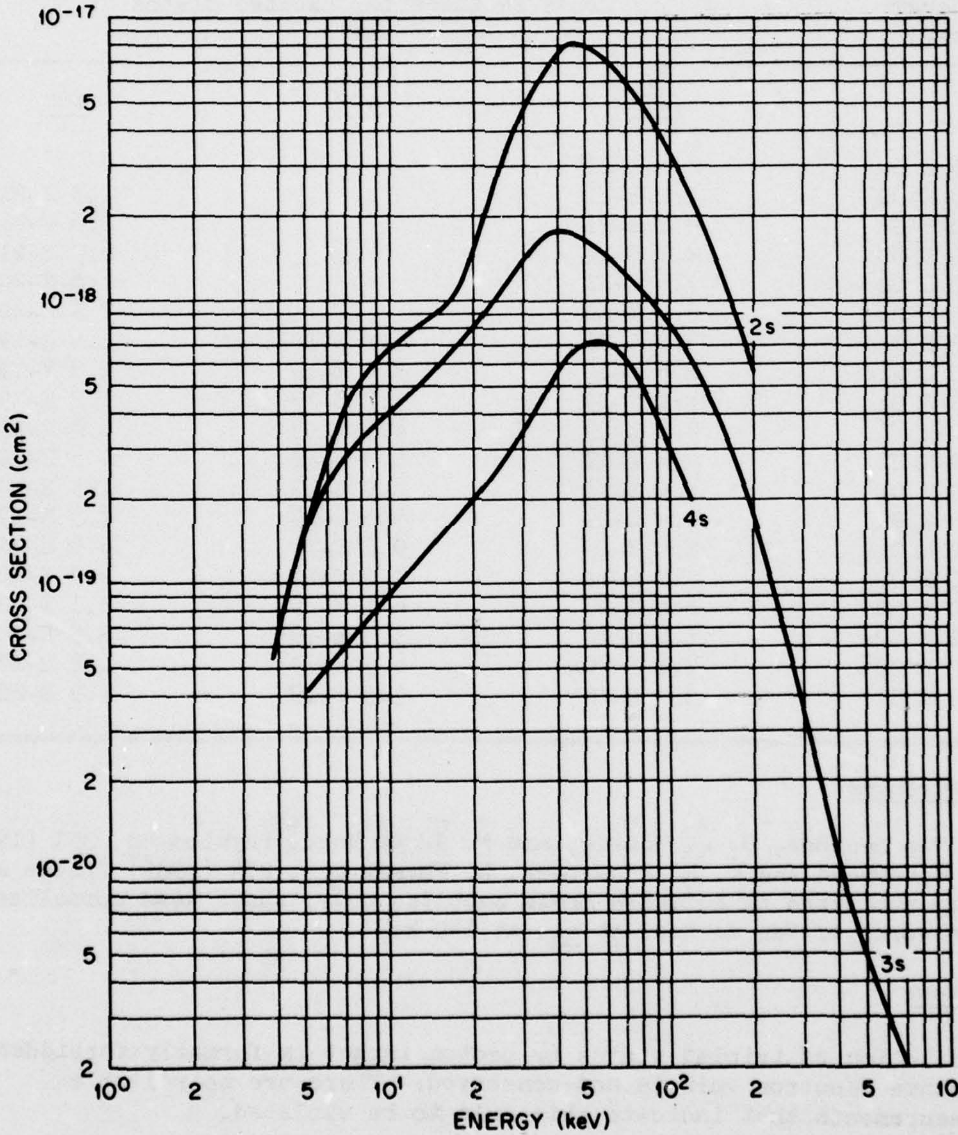
In all cases the cross sections have been deduced on the (unsubstantiated) assumption that cascade into relevant levels can be neglected.

Accuracy:

Systematic error < 50%. Random error < 15%.

Excitation Cross Sections by Electron Capture for the Reactions

$H^{+} + He \rightarrow H(2s, 3s, 4s) + He^{+}$



Graphical Data B-2.10.

Tabular Data B-2.11.

Excitation Cross Sections for the Reactions

$$H^+ + He \rightarrow H^+ + He\ (4^1S,\ 4^1P,\ 4^1D)$$

Energy (keV)	Cross Sections for Excited States $n\ell$ (cm^2)		
	4^1S	4^1P	4^1D
1.0 E 00	2.8 E-22		
2.0 E 00	1.2 E-21		2.3 E-21
3.0 E 00	2.0 E-21		3.6 E-21
4.0 E 00	2.2 E-21		6.9 E-21
5.0 E 00	4.6 E-21		1.8 E-20
7.0 E 00	3.9 E-20		7.5 E-20
1.0 E 01	8.6 E-20	1.2 E-19	1.4 E-19
2.0 E 01	1.6 E-19	3.2 E-19	1.3 E-19
3.0 E 01	4.1 E-19	3.7 E-19	1.2 E-19
4.0 E 01	4.8 E-19	4.5 E-19	1.4 E-19
5.0 E 01	4.8 E-19	5.8 E-19	1.5 E-19
7.0 E 01	4.4 E-19	8.0 E-19	1.5 E-19
1.0 E 02	3.4 E-19	9.6 E-19	1.3 E-19
2.0 E 02	1.8 E-19	9.2 E-19	6.6 E-20
3.0 E 02	1.2 E-19	7.3 E-19	4.3 E-20
4.0 E 02	8.8 E-20	6.1 E-19	3.1 E-20
5.0 E 02	7.0 E-20	5.3 E-19	2.5 E-20
7.0 E 02	5.0 E-20	4.3 E-19	1.8 E-20
1.0 E 03	3.7 E-20	3.3 E-19	1.3 E-20

References:

J. Van den Bos, G. J. Winter, and F. J. de Heer, Physica 40, 357 (1968); A. Scharmann and K. H. Schartner, Z. Physik 228, 254 (1969) (these data were published as relative cross sections only; shown here normalized to the works of Van de Bos, et al. at 140 keV).

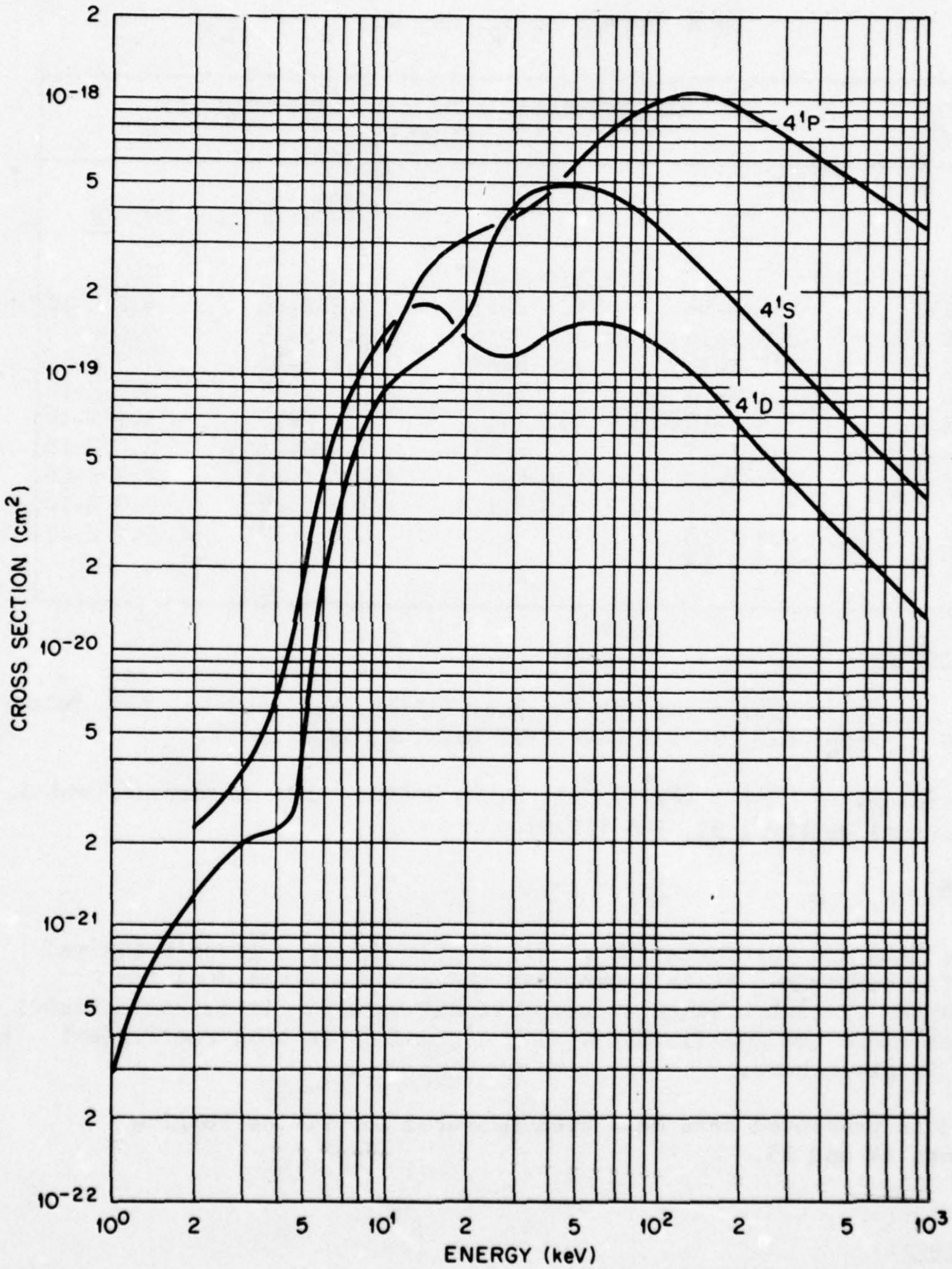
Notes:

Excitation of triplet states by proton impact is formally forbidden because electron spin is not conserved. There are no reliable measurements that indicate this rule to be violated.

Accuracy: Systematic error < 9%. Random error < 5%.

Excitation Cross Sections for the Reactions

$H^+ + He \rightarrow H^+ + He\ (4^1S,\ 4^1P,\ 4^1D)$



Graphical Data B-2.12.

Tabular Data B-2.13.

Cross Sections for Formation of H Atoms in High Excited States

by H^+ Impact on H_2, He, N_2, O_2

Energy (keV)	Coefficients $\sigma(n) \times n^3$ (see note 18) (cm^2)			
	H_2	He	N_2	O_2
1.5 E 01		5.0 E-17		
2.0 E 01	2.4 E-16	8.3 E-17	3.2 E-16	4.2 E-16
3.0 E 01	3.3 E-16	1.2 E-16	3.9 E-16	5.0 E-16
4.0 E 01	3.0 E-16	1.1 E-16	3.9 E-16	4.5 E-16
5.0 E 01	2.1 E-16	8.9 E-17	3.6 E-16	3.7 E-16
6.0 E 01	1.4 E-16	7.3 E-17	3.1 E-16	3.1 E-16
7.0 E 01	9.3 E-17	5.7 E-17	2.4 E-16	2.6 E-16
8.0 E 01	6.7 E-17	4.6 E-17	2.0 E-16	2.3 E-16
1.0 E 02	3.5 E-17	2.9 E-17	1.3 E-16	1.7 E-16
1.5 E 02	9.3 E-18		6.0 E-17	9.7 E-17
1.8 E 02	4.0 E-18			

References:

$H^+ + (H_2,He) \rightarrow H(n) + (H_2^+,He^+)$: R.N. Il'lin, V.A. Oparin, E.S. Solov'ev, and N.V. Fedorenko, Soviet Phys-JETP Lett. 2, 197 (1965).

$H^+ + (N_2,O_2) \rightarrow H(n) + (N_2^+,O_2^+)$: R. Le Doucen, J.M. Lenormand, and J. Guidini, Le Journal de Phys. 31, 965 (1970).

Notes:

These data are for formation of all states having a given principal quantum number n. It is known that the cross section $\sigma(n)$ for formation of such a state is proportional to n^{-3}. It is conventional to determine the coefficient $\sigma(n) \times n^3$, and it is this coefficient that is given here.

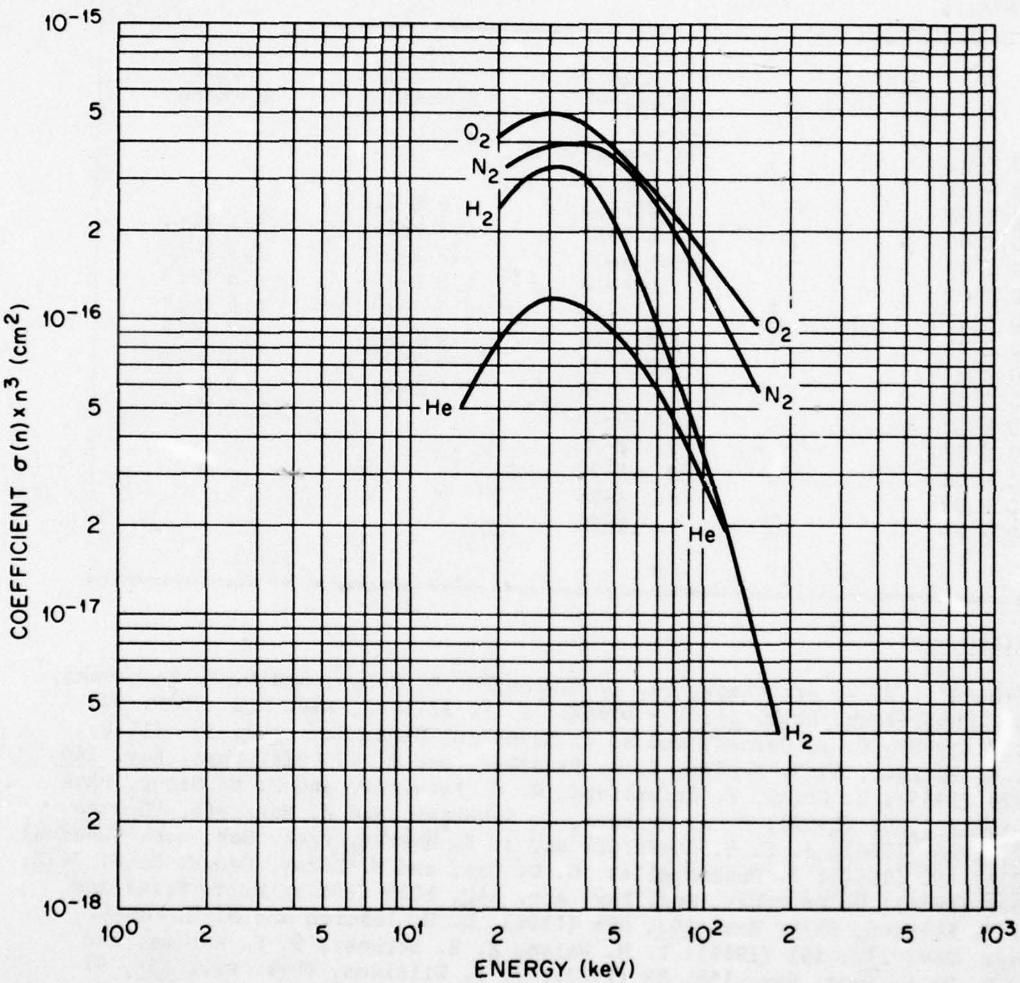
The data presented here have been measured for states ranging between 10 and 15.

Accuracy:

Systematic error < 10%. Random error < 10%.

Cross Sections for Formation of H Atoms in High Excited States

by H^+ Impact on H_2, He, N_2, O_2



Graphical Data B-2.14.

Tabular Data B-2.15.

Electron Capture Cross Sections for H^+ and H°

Passing Through Helium

Energy (keV)	Cross Sections (cm^2)		
	σ_{10} $H^+ + He \rightarrow H^\circ$	σ_{1-1} $H^+ + He \rightarrow H^-$	σ_{0-1} $H^\circ + He \rightarrow H^-$
2.0 E-01	1.5 E-18		
5.0 E-01	2.9 E-18		
1.0 E 00	5.2 E-18	1.6 E-21	
2.0 E 00	1.0 E-17	4.7 E-21	5.4 E-19
5.0 E 00	3.1 E-17	2.3 E-20	2.3 E-18
1.0 E 01	1.0 E-16	1.0 E-19	4.8 E-18
2.0 E 01	2.1 E-16	3.5 E-19	6.6 E-18
5.0 E 01	1.1 E-16	5.0 E-19	4.7 E-18
1.0 E 02	3.0 E-17	3.3 E-20	1.3 E-18
2.0 E 02	3.3 E-18	1.0 E-21	2.3 E-19
5.0 E 02	8.3 E-20		1.0 E-20
1.0 E 03	3.6 E-21		
2.0 E 03	1.1 E-22		
5.0 E 03	8.5 E-25		
1.0 E 04	1.4 E-26		

References:

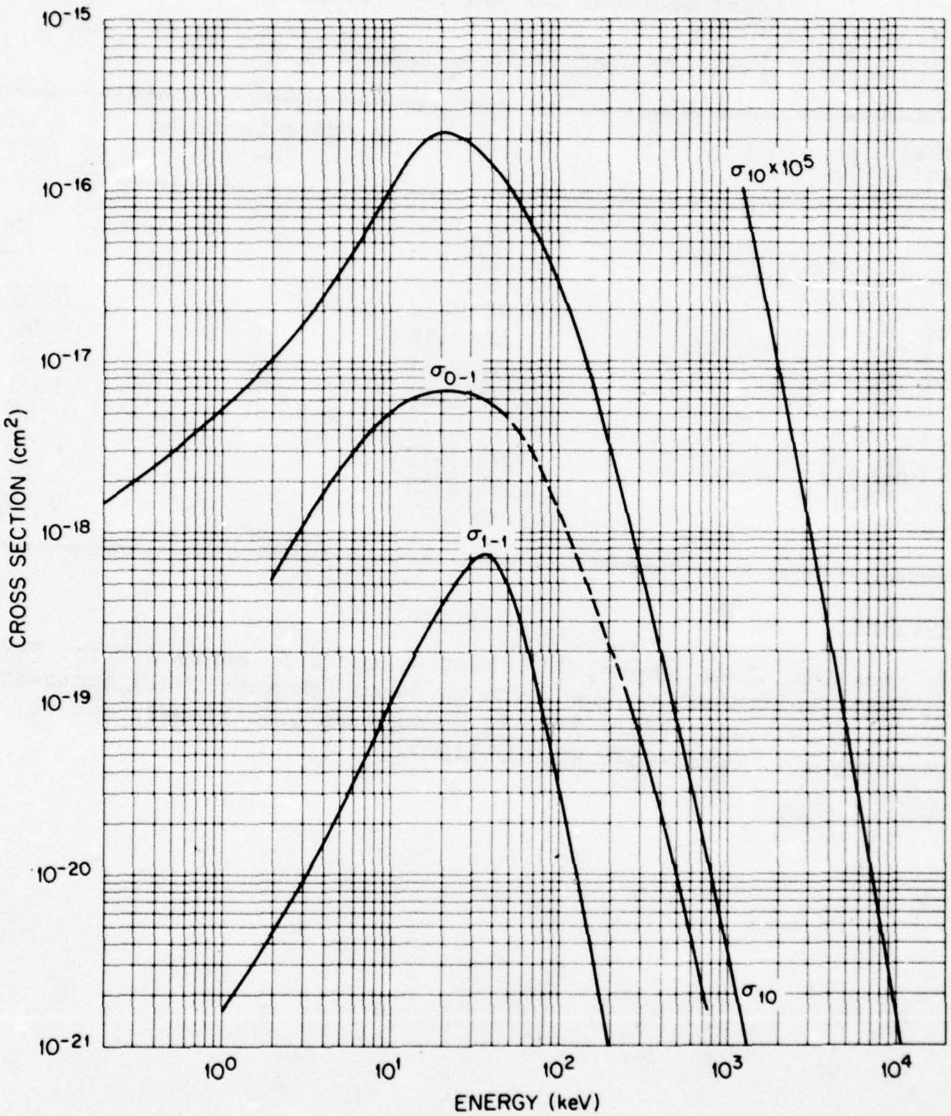
$H^+ + He \rightarrow H^\circ$: V. V. Afrosimov, Yu. A. Mamaev, M. N. Panov, and N. V. Fedorenko, Sov. Phys.-Tech. Phys. 14, 109 (1969); S. K. Allison, Rev. Mod. Phys. 30, 1137 (1958); C. F. Barnett and H. K. Reynolds, Phys. Rev. 109, 355 (1958); K. H. Berkner, S. N. Kaplan, G. A. Paulikas, and R. V. Pyle, Phys. Rev. 140, A729 (1965); L. Colli, F. Cristofori, G. E. Frigerio, and P. G. Stone, Phys. Letters 3, 62 (1962); F. J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1766 (1966); J. B. H. Stedeford and J. B. Hasted, Proc. Roy. Soc. (London) 227A, 466 (1954); J. Desesquelles, G. D. Cao, and M. Dufay, Compt. Rend. 262B, 1329 (1966); U. Schryber, Hel. Phy. Act. A40, 1023 (1962); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956); L. H. Toburen and M. Y. Nakai, Phys. Rev. 177, 191 (1969); L. M. Welsh, K. H. Berkner, S. N. Kaplan, and R. V. Pyle, Phys. Rev. 158, 85 (1967); J. F. Williams, Phys. Rev. 157, 97 (1967).

$H^+ + He \rightarrow H^-$: V. F. Kozlov and S. A. Bonder, Sov. Phys.-JETP 23, 195 (1966); Ya. M. Fogel, Sov. Phys.-Usp. 3, 390 (1960); U. Schryber, Hel. Phy. Act. A40, 1023 (1967); L. H. Toburen and M. Y. Nakai, Phys. Rev. 177, 191 (1969); J. F. Williams, Phys. Rev. 150, 7 (1966).

$H^\circ + He \rightarrow H^-$: Ya. M. Fogel, V. A. Ankudinov, D. V. Pilipenko, and N. V. Topolia, Sov. Phys.-JETP 34, 400 (1958); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956); U. Schryber, Hel. Phy. Act. A40, 1023 (1967).

Electron Capture Cross Sections for H^+ and H°

Passing Through Helium



Accuracy:

σ_{10} ± 25%

σ_{1-1} E > 10 keV ± 25%; E > 10 keV ± 60%

σ_{0-1} ± 25%

Notes:

Berkner, et al., results for D^+ in He has been plotted at E/2.

Graphical Data B-2.16.

Tabular Data B-2.17.

Cross Sections for the Production of

Positive Charges in H_2 and He by H^+

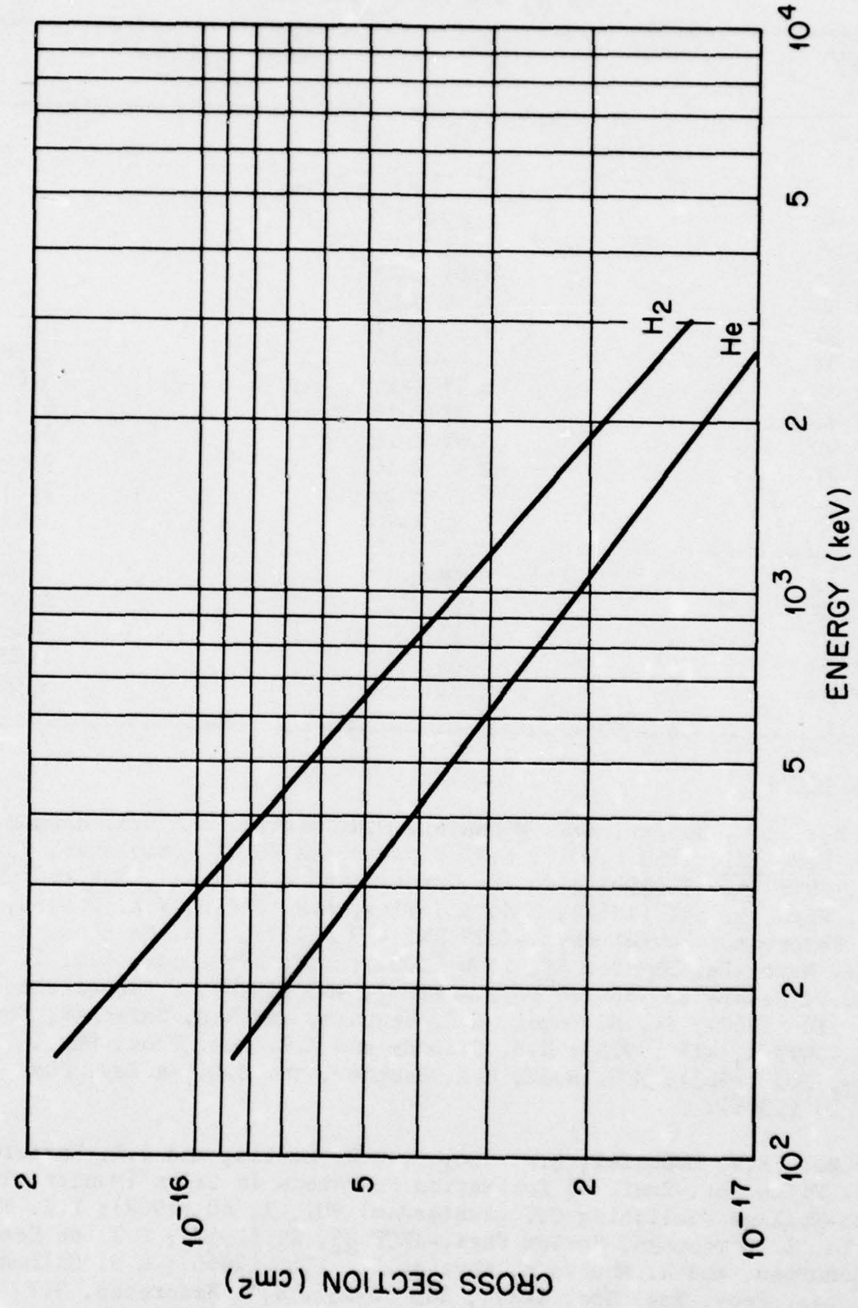
Energy (keV)	Cross Sections (cm^2)	
	H_2	He
1.5 E 02	1.77 E-16	8.66 E-17
2.0 E 02	1.40 E-16	6.99 E-17
4.0 E 02	7.59 E-17	4.16 E-17
6.0 E 02	5.37 E-17	3.08 E-17
8.0 E 02	4.18 E-17	2.48 E-17
1.0 E 03	3.44 E-17	2.09 E-17
2.0 E 03	1.91 E-17	1.24 E-17
3.0 E 03	1.35 E-17	9.29 E-18

References:

E.W. McDaniel, J.W. Hooper, D.W. Martin, and D.S. Harmer, Proc. Fifth Int. Conf. on Ionization Phenomena in Gases (Munich, 1961) North-Holland Publishing Co. (Amsterdam) Vol. 1, 60 (1962); L.I. Pivovar and Yu. Z. Levchenko, Sov. Phys.-JETP 25, 27 (1967).

Cross Sections for the Production of

Positive Charges in H_2 and He by H^+



Graphical Data B-2.18.

Tabular Data B-2.19.

Cross Sections for Production of Free Electrons in H_2 and He by Protons

Energy (keV)	Cross Sections (cm^2) H_2	Cross Sections (cm^2) He
1.0 E 00	2.81 E-17	
2.0 E 00	4.18 E-17	
4.0 E 00	6.19 E-17	
6.0 E 00	7.96 E-17	
8.0 E 00	9.29 E-17	
1.0 E 01	1.05 E-16	2.18 E-17
2.0 E 01	1.55 E-16	3.60 E-17
4.0 E 01	2.27 E-16	6.08 E-17
6.0 E 01	2.57 E-16	8.23 E-17
8.0 E 01	2.47 E-16	9.52 E-17
1.0 E 02	2.26 E-16	9.87 E-17
2.0 E 02	1.36 E-16	7.01 E-17
4.0 E 02	7.48 E-17	4.15 E-17
6.0 E 02	5.30 E-17	3.04 E-17
8.0 E 02	4.20 E-17	2.47 E-17
1.0 E 03	3.35 E-17	2.09 E-17
2.0 E 03	1.84 E-17	1.23 E-17
3.0 E 03	1.30 E-17	9.00 E-18

References:

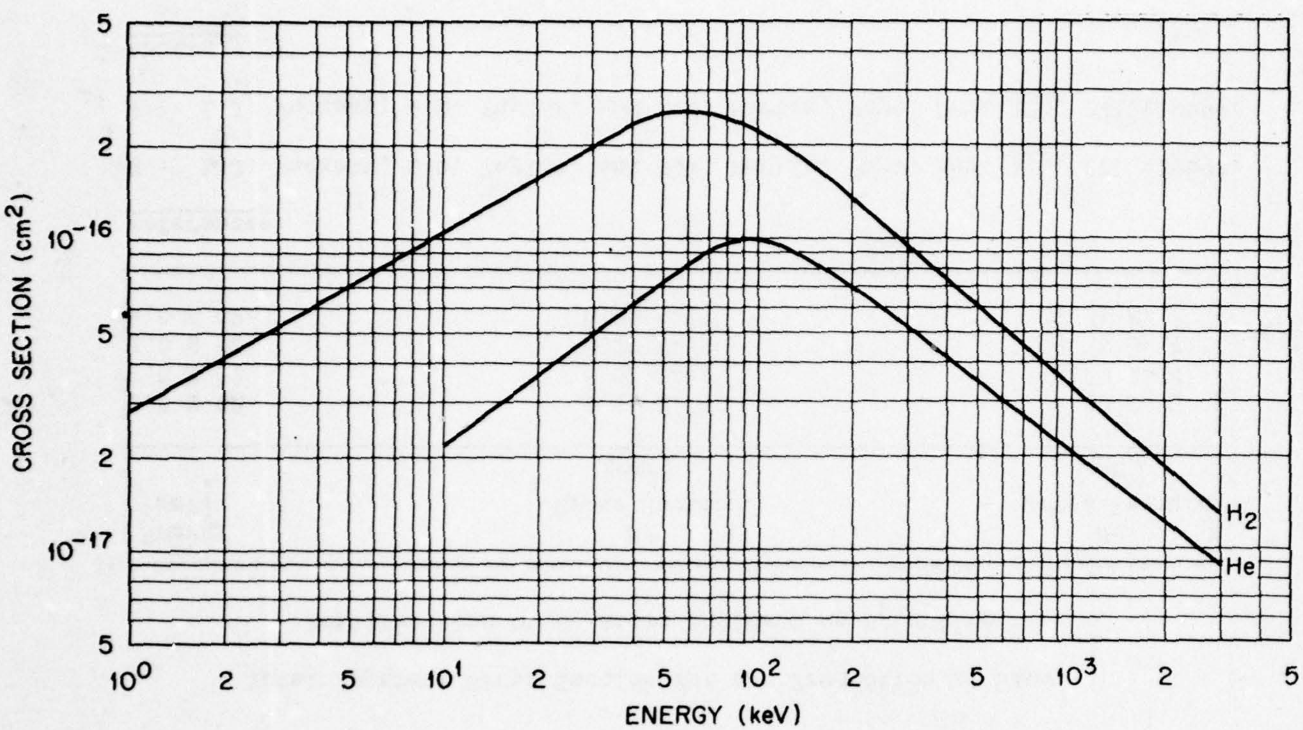
$H^+ + H_2$: J.W. Hooper, E.W. McDaniel, D.W. Martin, and D.S. Harmer, Phys. Rev. 121, 1123 (1961); L.I. Pivovar and Yu. Z. Levchenko, Soviet Phys.-JETP 25, 27 (1967); Yu. S. Gordeev and M.N. Panov, Soviet Phys.-Tech. Phys. 9, 656 (1964); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Soviet Phys.-JETP 15, 459 (1962); F.J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1766 (1966); V.V. Afrosimov, R.N. Il'in, and N.V. Fedorenko, Soviet Phys.-JETP 7, 968 (1958); F. Schwirzke, Z. Phys. 157, 510 (1960); Ya. M. Fogel, L.I. Krupnik, and B.G. Safronov, Soviet Phys.-JETP 1, 415 (1955); H.B. Gilbody and A.R. Lee, Proc. Phys. Soc. A-274, 365 (1963); M.E. Rudd, C.A. Sautter, and C.L. Bailey, Phys. Rev. 151, 20 (1966).

H^+ + He: E.W. McDaniel, J.W. Hooper, D.W. Martin, and D.S. Harmer, Proc. Fifth Int. Conf. on Ionization Phenomena in Gases (Munich, 1961) North-Holland Publishing Co. (Amsterdam) Vol. 1, 60 (1962); L.I. Pivovar and Yu. Z. Levchenko, Soviet Phys.-JETP 25, 27 (1967); F.J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1766 (1966); H.B. Gilbody and A.R. Lee, Proc. Roy. Soc. A-274, 365 (1963); N.V. Fedorenko, V.V. Afrosimov, R.N. Il'in, and E.S. Solov'ev, Proc. Fourth Int. Conf. on Ionization Phenomena in Gases (Uppsala, 1959), North Holland Publishing Co. (Amsterdam) Vol. 1, IA-47 (1960).

Accuracy: $\pm$ 25%.

Cross Sections for Production of Free Electrons

in H_2 and He by Protons



Graphical Data B-2.20.

Tabular Data B-2.21.

Total Apparent Cross Section for the Production of Slow

Positive Ions by H^{o} Atoms Incident on H_2 and He

Energy (keV)	H_2 Cross Section (cm^2)	He Cross Section (cm^2)
1.5 E 02	9.15 E-17	4.00 E-17
2.0 E 02	8.01 E-17	3.80 E-17
3.0 E 02	6.20 E-17	3.15 E-17
4.0 E 02	4.99 E-17	2.61 E-17

References:

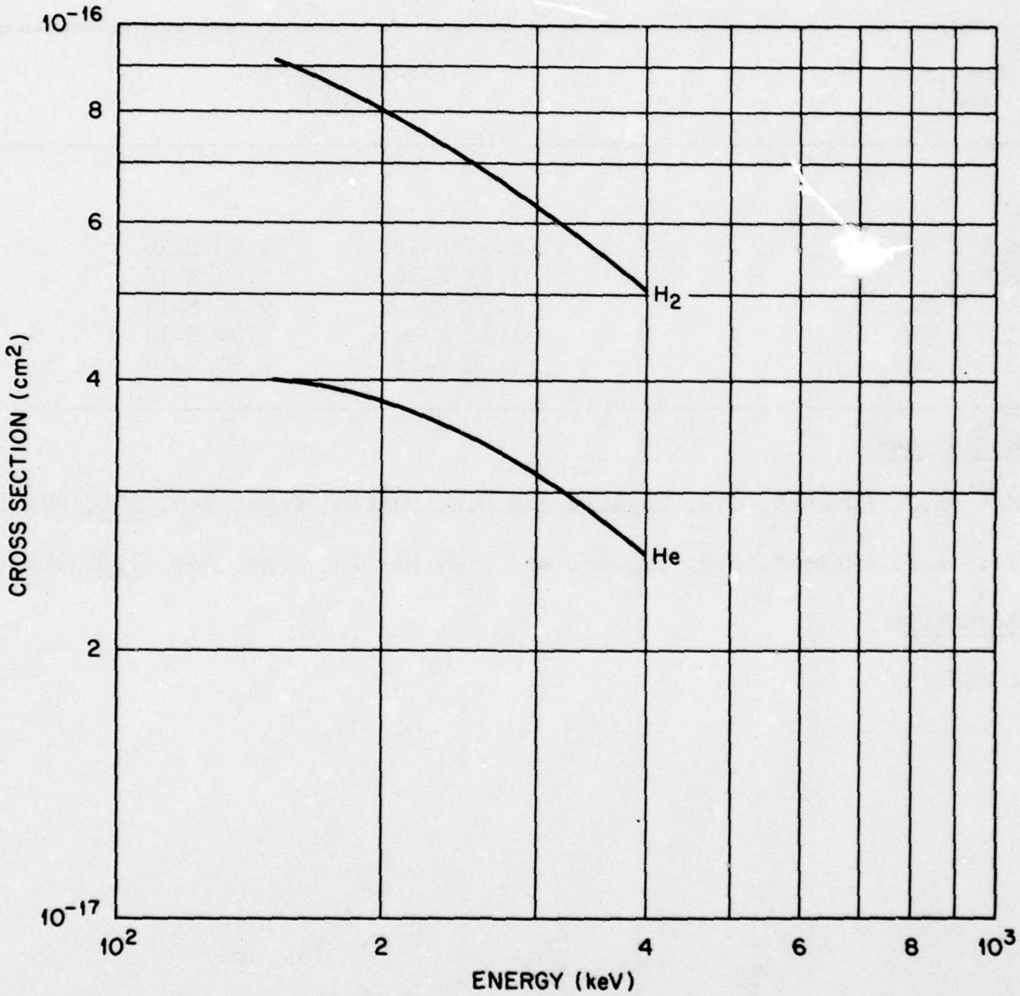
H_2: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969).

He: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969).

Accuracy:

± 20%.

Total Apparent Cross Section for the Production of Slow Positive Ions by H^o Atoms Incident on H_2 and He



Graphical Data B-2.22.

Tabular Data B-2.23.

Total Cross Section for the Production of

Free Electrons by H^o Atoms in H_2 and He

Energy (keV)	Cross Sections (cm^2) H_2	He
1.5 E 02	1.91 E-16	1.08 E-16
2.0 E 02	1.67 E-16	1.04 E-16
2.5 E 02	1.35 E-16	9.00 E-17
3.0 E 02	1.12 E-16	8.00 E-17
3.3 E 02	1.00 E-16	7.50 E-17

<u>Reference</u>:

H_2: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. <u>178</u>, 271 (1969).

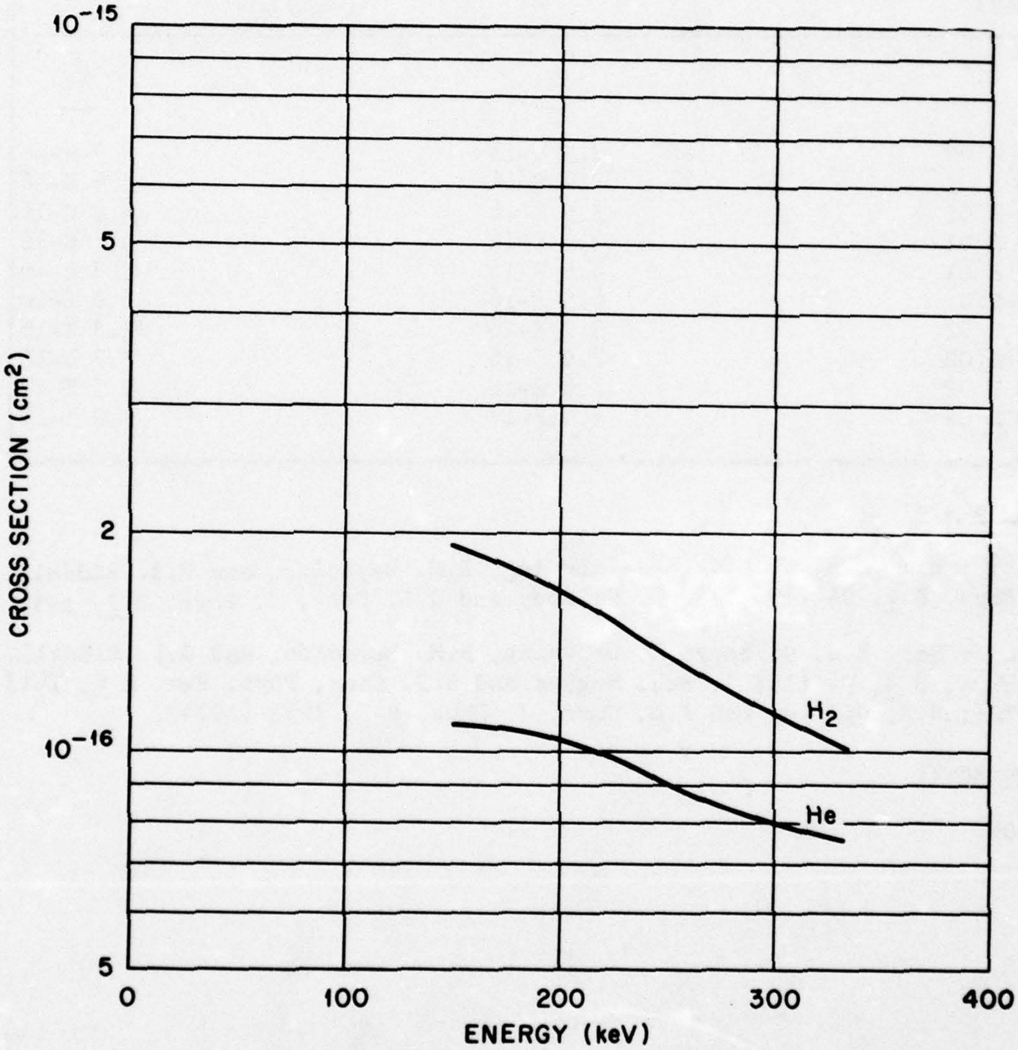
He: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. <u>178</u>, 271 (1969).

<u>Accuracy</u>:

± 20%.

Total Cross Section for the Production of

Free Electrons by H^{o} Atoms in H_2 and He



Graphical Data B-2.24.

Tabular Data B-2.25.

Cross Sections for Electron Loss or Stripping

for Metastable H(2s) Atoms in H_2 and He

Energy (keV)	Cross Sections (cm^2) H_2	He
5.0 E 00	2.5 E-16	2.9 E-16
1.0 E 01	2.9 E-16	3.4 E-16
1.5 E 01	3.5 E-16	3.2 E-16
2.0 E 01	3.9 E-16	3.1 E-16
4.0 E 01	4.5 E-16	2.3 E-16
5.0 E 01	4.5 E-16	2.0 E-16
1.0 E 02	3.2 E-16	1.3 E-16
2.0 E 02	2.0 E-16	7.7 E-17
4.0 E 02	1.0 E-16	5.5 E-17
5.0 E 02	8.0 E-17	5.0 E-17

References:

H(2s) + H_2: H.B. Gilbody, R. Browning, R.M. Reynolds, and G.I. Riddell, J. Phys. B 4, 94 (1971); H.B. Gilbody and J.L. Corr, J. Phys. B 7, 1953 (1974).

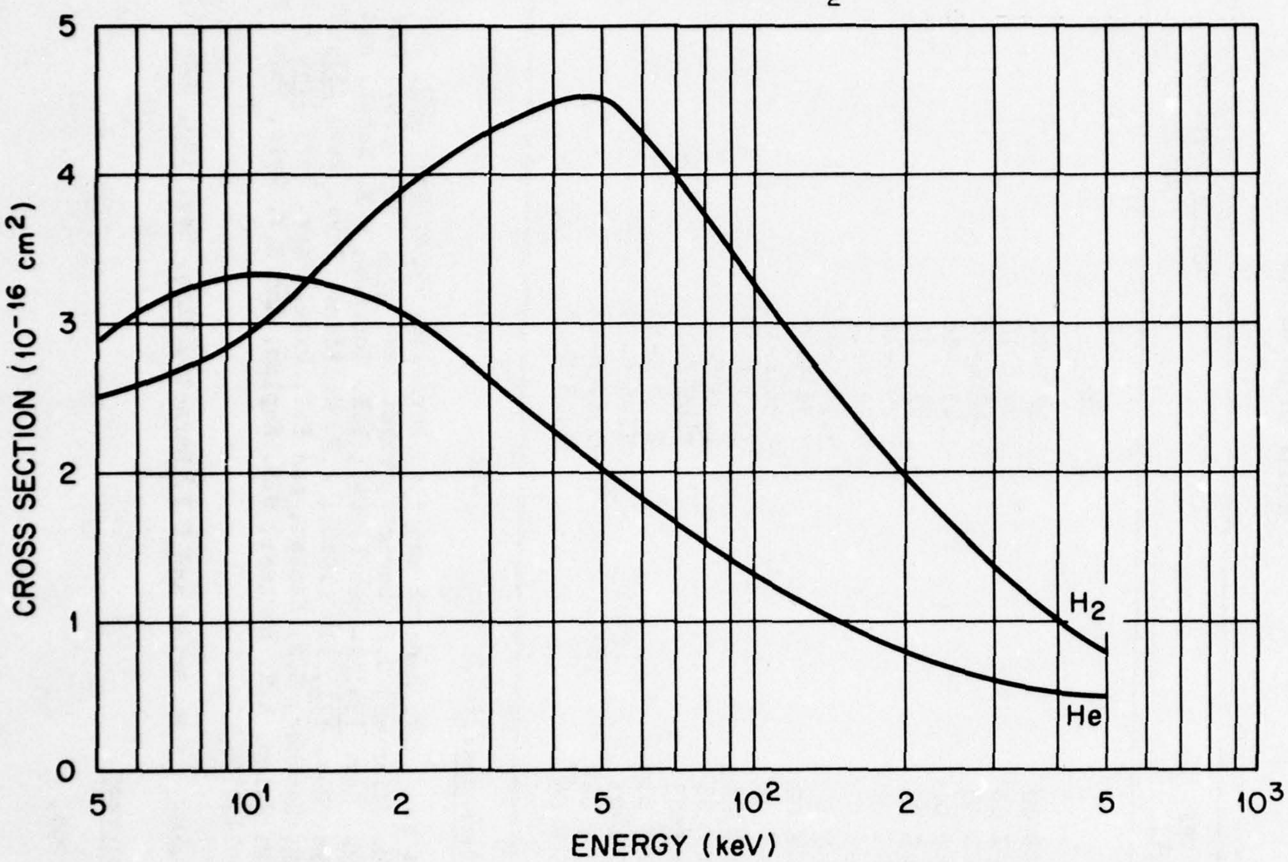
H(2s) + He: H.B. Gilbody, R. Browning, R.M. Reynolds, and G.I. Riddell, J. Phys. B 4, 94 (1971); R.H. Hughes and S.S. Choe, Phys. Rev. A 6, 1413 (1972); H.B. Gilbody and J.L. Corr, J. Phys. B 7, 1953 (1974).

Accuracy:

± 20%

Cross Sections for Electron Loss or Stripping

for Metastable H(2s) Atoms in H_2 and He



Graphical Data B-2.26.

Tabular Data B-2.27.

Cross Sections for Electron Stripping

H Atoms in He and Ne

Energy (keV)	Cross Sections (cm^2)	
	He	Ne
4.2 E 00	1.22 E-16	6.67 E-17
6.0 E 00	1.44 E-16	8.91 E-17
8.0 E 00	1.49 E-16	1.09 E-16
1.0 E 01	1.47 E-16	1.23 E-16
2.0 E 01	1.35 E-16	1.69 E-16
5.0 E 01	1.23 E-16	2.00 E-16
8.0 E 01	9.70 E-17	1.99 E-16
1.0 E 02	9.18 F-17	1.94 E-16
2.0 E 02	5.76 E-17	1.62 E-16
5.0 E 02	2.56 E-17	
8.0 E 02	1.63 E-17	
1.0 E 03	1.33 E-17	
2.0 E 03	7.05 E-18	
5.0 E 03	2.58 E-18	
8.0 E 03	1.98 E-18	
1.0 E 04	1.60 E-18	
1.5 E 04	1.13 E-18	

References:

H + He: C.F. Barnett and H.K. Reynolds, Phys. Rev. 109, 355 (1958); P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956); G.W. McClure, Phys. Rev. 134, A-1226 (1964); L.H. Toburen, M.Y. Nakai, and R.A. Langley, Phys. Rev. 171, 114 (1968); J.F. Williams, Phys. Rev. 157, 97 (1967); K.H. Berkner, S.N. Kaplan, and R.V. Pyle, Phys. Rev. 134, A-1461 (1964); L.M. Welsh, K.H. Berkner, S.N. Kaplan, and R.V. Pyle, Phys. Rev. 158, 85 (1967).

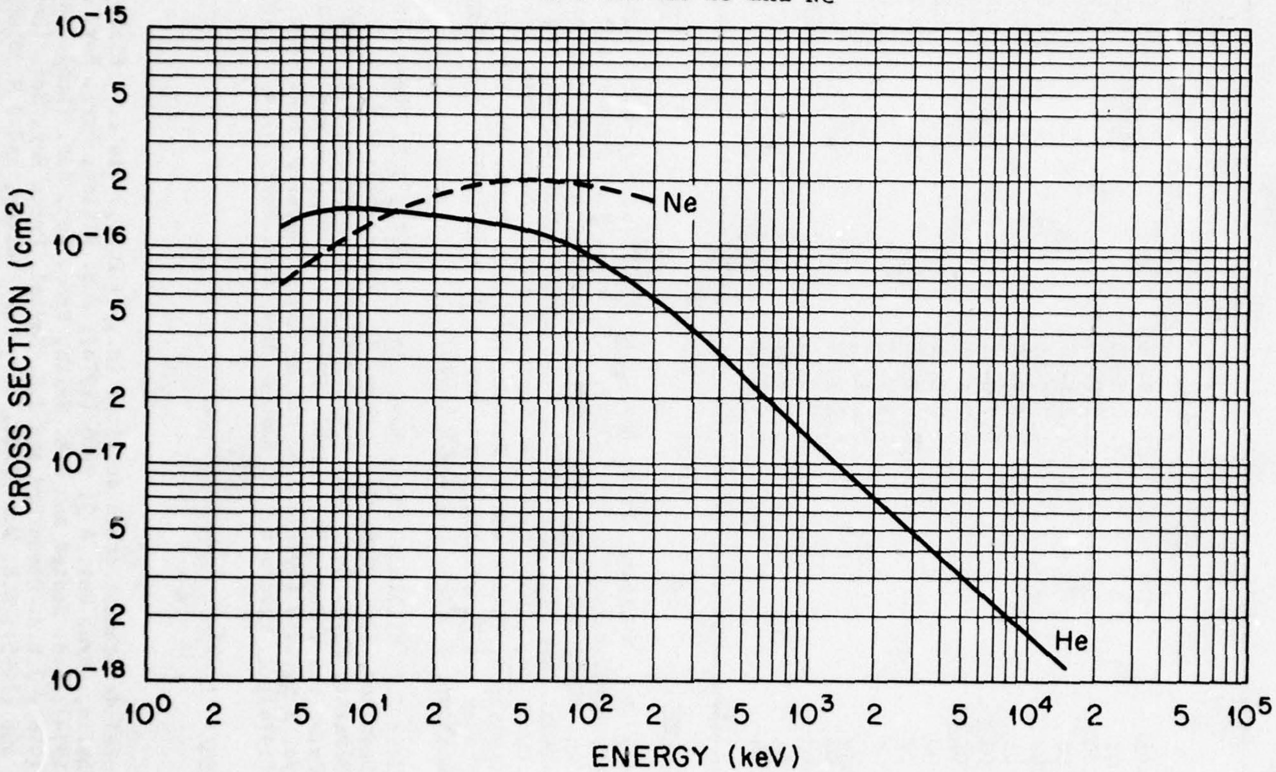
H + Ne: P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956).

Accuracy:

± 20%.

Cross Sections for Electron Stripping

H Atoms in He and Ne



Graphical Data B-2.28.

Tabular Data B-2.29.

Cross sections for one electron loss or stripping for H^- in H_2 and He

Energy (keV)	Cross Sections (cm^2) H_2	He
2.0 E-01	7.5 E-16	4.6 E-16
5.0 E-01	1.0 E-15	5.2 E-16
1.0 E 00	1.1 E-15	5.8 E-16
2.0 E 00	1.2 E-15	6.1 E-16
5.0 E 00	1.2 E-15	6.0 E-16
1.0 E 01	1.0 E-15	5.4 E-16
2.0 E 01	8.7 E-16	4.4 E-16
5.0 E 01	6.0 E-16	3.2 E-16
1.0 E 02	4.0 E-16	2.2 E-16
2.0 E 02	2.6 E-16	1.5 E-16
5.0 E 02	1.3 E-17	7.3 E-17
1.0 E 03	7.2 E-17	4.0 E-17
2.0 E 03	3.3 E-17	2.2 E-17
5.0 E 03	1.2 E-17	9.0 E-18
1.0 E 04	5.5 E-18	4.7 E-18
1.7 E 04	2.7 E-18	

References:

H^- + H_2: J.F. Williams, Phys. Rev. 154, 9 (1967); P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956); P.H. Rose, R.J. Connor, and R.P. Bastide, Bull. Am. Phys. Soc. II-3, 40 (1958); G.I. Dimov and V.G. Dudnikov, Sov. Phys.-Tech. Phys. 11, 919 (1967); K.H. Berkner, S.N. Kaplan, and R.V. Pyle, Phys. Rev. 134, A1461 (1964); R. Smythe and J.W. Toevs, Phys. Rev. 139, A-15 (1965); H. Tawara and A. Russek, Rev. Mod. Phys. 45, 178 (1973); J.S. Risley and R. Geballe, Phys. Rev. A 9, 2485 (1974); F.R. Simpson and H.B. Gilbody, J. Phys. B 5, 1959 (1972).

H^- + He: J.F. Williams, Phys. Rev. 154, 9 (1967); G.I. Dimov and V.G. Dudnikov, Sov. Phys.-Tech. Phys. 11, 919 (1967); P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956); K.H. Berkner, S.N. Kaplan, and R.V. Pyle, Phys. Rev. 134, A-1461 (1964); F.R. Simpson and H.B. Gilbody, J. Phys. B 5, 1959 (1972); J.S. Risley and R. Geballe, Phys. Rev. A 9, 2485 (1974); H. Tawara and A. Russek, Rev. Mod. Phys. 45, 178 (1973).

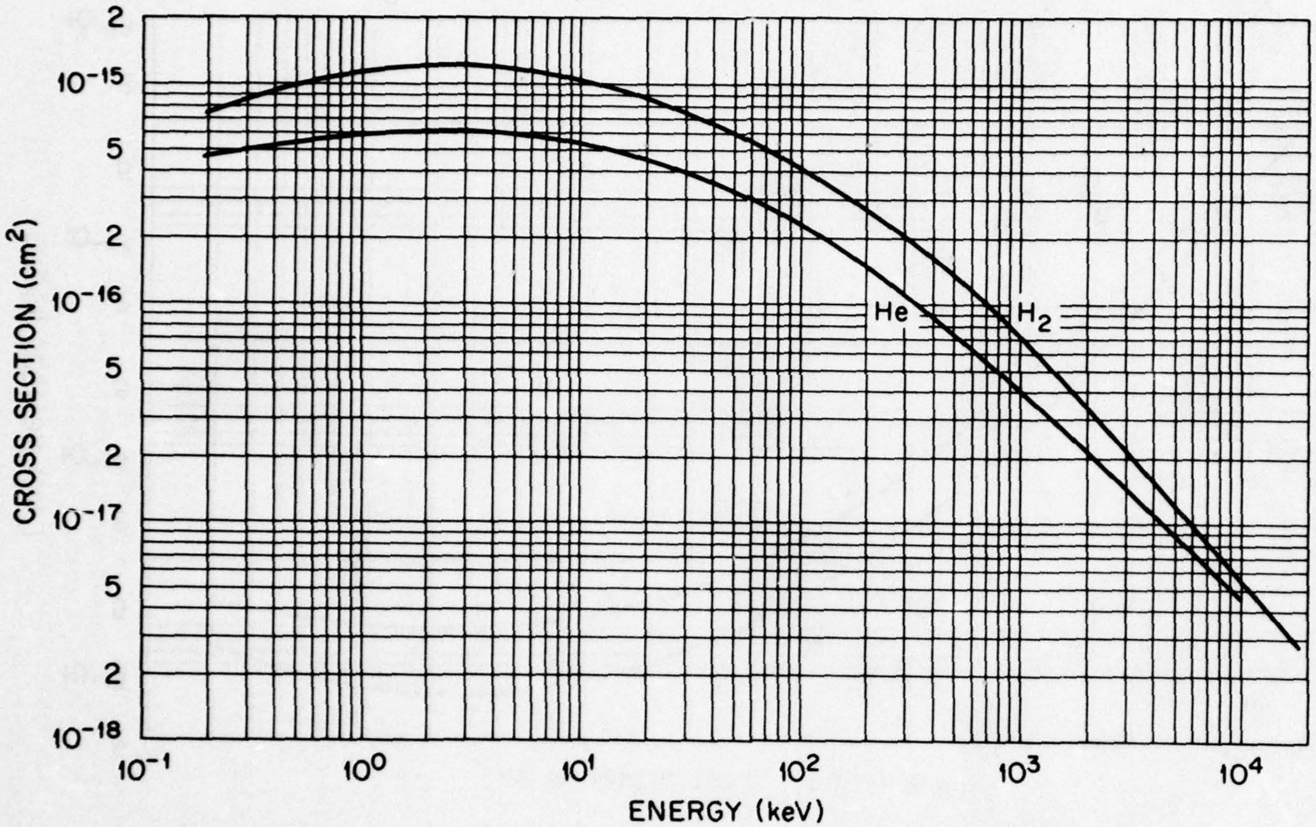
Accuracy: $\pm$ 25%.

Note:

For total detachment cross sections ($\sigma_{-10} + 2\sigma_{-11}$) see J.S. Risley and R. Geballe, Phys. Rev. A 9, 2485 (1974); J.S. Risley, Phys. Rev. A 10, 731 (1974); J.B. Hasted and R.A. Smith, Proc. Roy. Soc. (Lond.) A235, 349 (1956); J.B.H. Stedeford and J.B. Hasted, Proc. Roy. Soc. (Lond.) A227, 466 (1955); E.E. Muschlitz, Jr., T.L. Bailey, and J.H. Simons, J. Chem. Phys. 24, 1202 (1956) and J. Chem. Phys. 26, 711 (1957).

Cross Sections for One Electron Loss

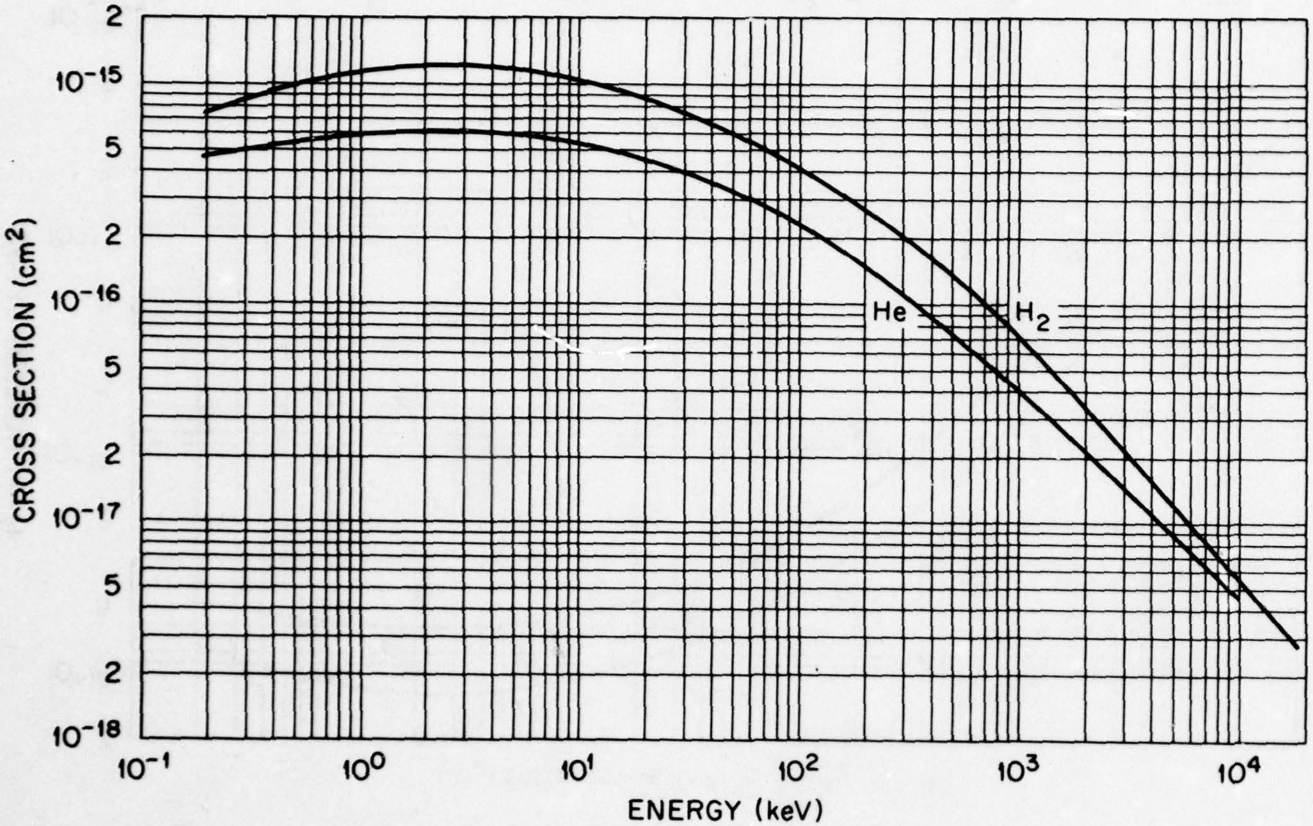
or Stripping for H^- in H_2 and He



Graphical Data B-2.30.

Cross Sections for One Electron Loss

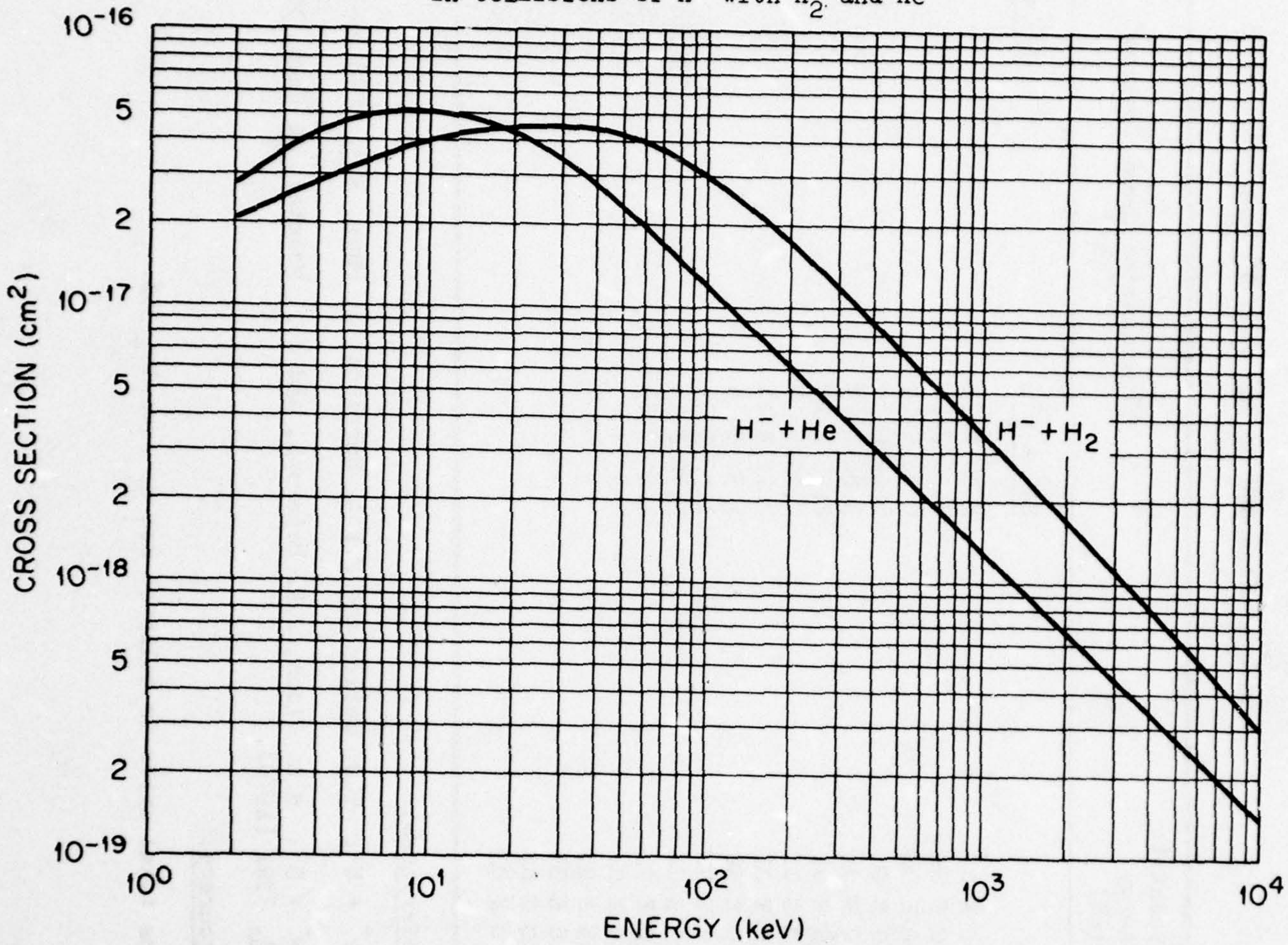
or Stripping for H^- in H_2 and He



Graphical Data B-2.30.

Cross Sections for Loss of Two Electrons

in Collisions of H^- with H_2 and He



Graphical Data B-2.32.

Tabular Data B-2.33.

Cross Sections for the Two-Body Recombination of He^+ with H^- Ions and of He^+ with D^- Ions

Barycentric Energy (eV)	Recombination Cross Section (cm^2)	
	$He^+ + D^-$	$He^+ + H^-$
1.0 E 00	1.00 E-13	
2.0 E 00	7.36 E-14	
3.0 E 00	6.14 E-14	
5.0 E 00	5.09 E-14	
1.0 E 01	3.88 E-14	
2.0 E 01	2.98 E-14	
3.0 E 01	2.59 E-14	
5.0 E 01	2.18 E-14	
1.0 E 02	1.78 E-14	
2.0 E 02	1.53 E-14	
3.0 E 02	1.42 E-14	1.44 E-14
5.0 E 02	1.25 E-14	1.23 E-14
9.0 E 02		1.09 E-14
1.5 E 03		9.06 E-15
2.0 E 03		9.27 E-15
4.0 E 03		4.42 E-15
6.0 E 03		1.93 E-15

References:

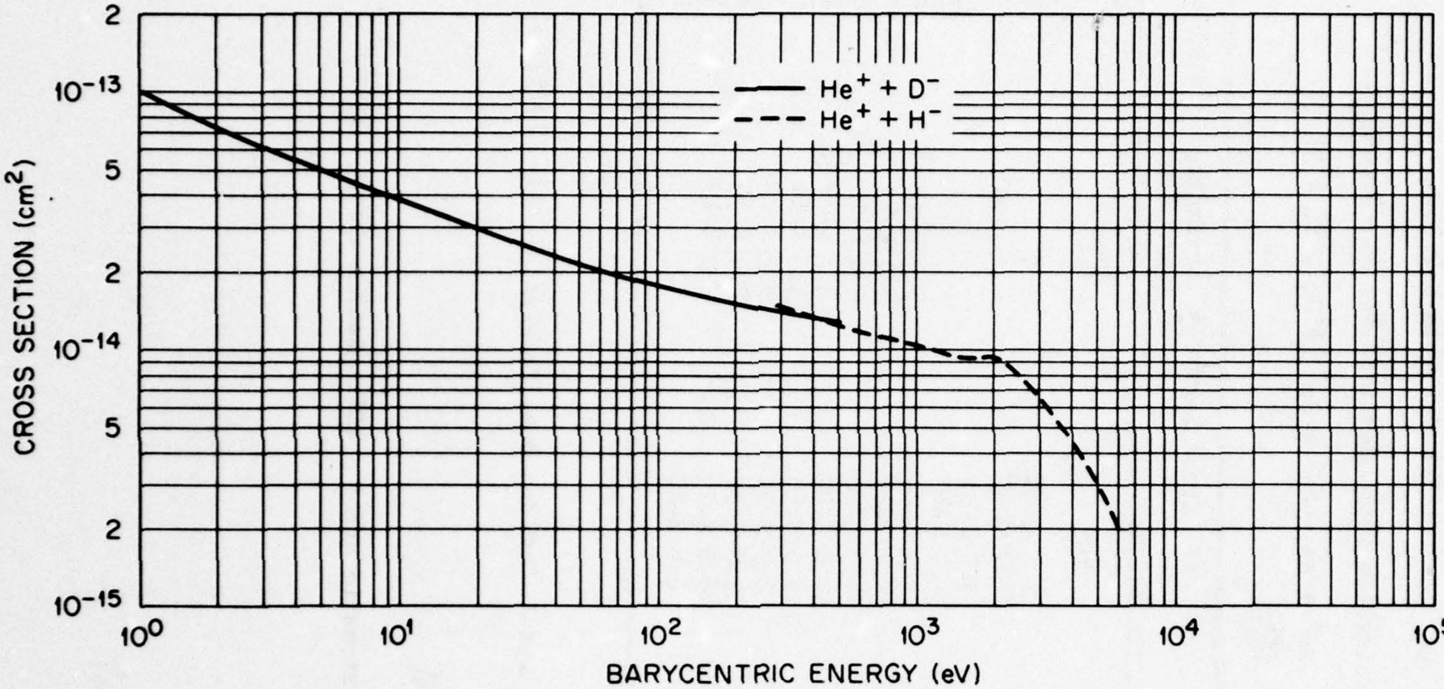
$He^+ + H^-$: T.D. Gailey and M.F.A. Harrison, J. Phys. B 3, 1098 (1970).

$He^+ + D^-$: R.E. Olson, J.R. Peterson, and J.T. Moseley, J. Chem. Phys. 53, 3391 (1970).

Accuracy:

The total error is believed not to exceed ± 35%.

Cross Sections for the Two-Body Recombination of He^+ with H^- Ions and of He^+ with D^- Ions



Graphical Data B-2.34.

Tabular Data B-2.35.

Excitation Cross Sections for the Reactions

$$He^+ + He \rightarrow He^+ + He^* \ (4^1S,\ 4^1P,\ 4^1D)$$

Energy (keV)	Cross Sections for Excited State $n\ell$ (cm^2)		
	4^1S	4^1P	4^1D
5.0 E 00	2.2 E-20		5.3 E-20
6.0 E 00	2.6 E-20		5.6 E-20
8.0 E 00	3.7 E-20		6.5 E-20
1.0 E 01	4.9 E-20		7.7 E-20
1.5 E 01	3.5 E-20	3.0 E-19	6.9 E-20
2.0 E 01	4.0 E-20	3.0 E-19	1.1 E-19
3.0 E 01	4.9 E-20	2.6 E-19	2.8 E-19
4.0 E 01	7.8 E-20	3.3 E-19	2.9 E-19
5.0 E 01	9.9 E-20	3.0 E-19	2.0 E-19
6.0 E 01	8.7 E-20	2.6 E-19	1.2 E-19
7.0 E 01	7.2 E-20	2.4 E-19	8.1 E-20
8.0 E 01	6.8 E-20	2.2 E-19	7.3 E-20
1.0 E 02	6.6 E-20		6.7 E-20

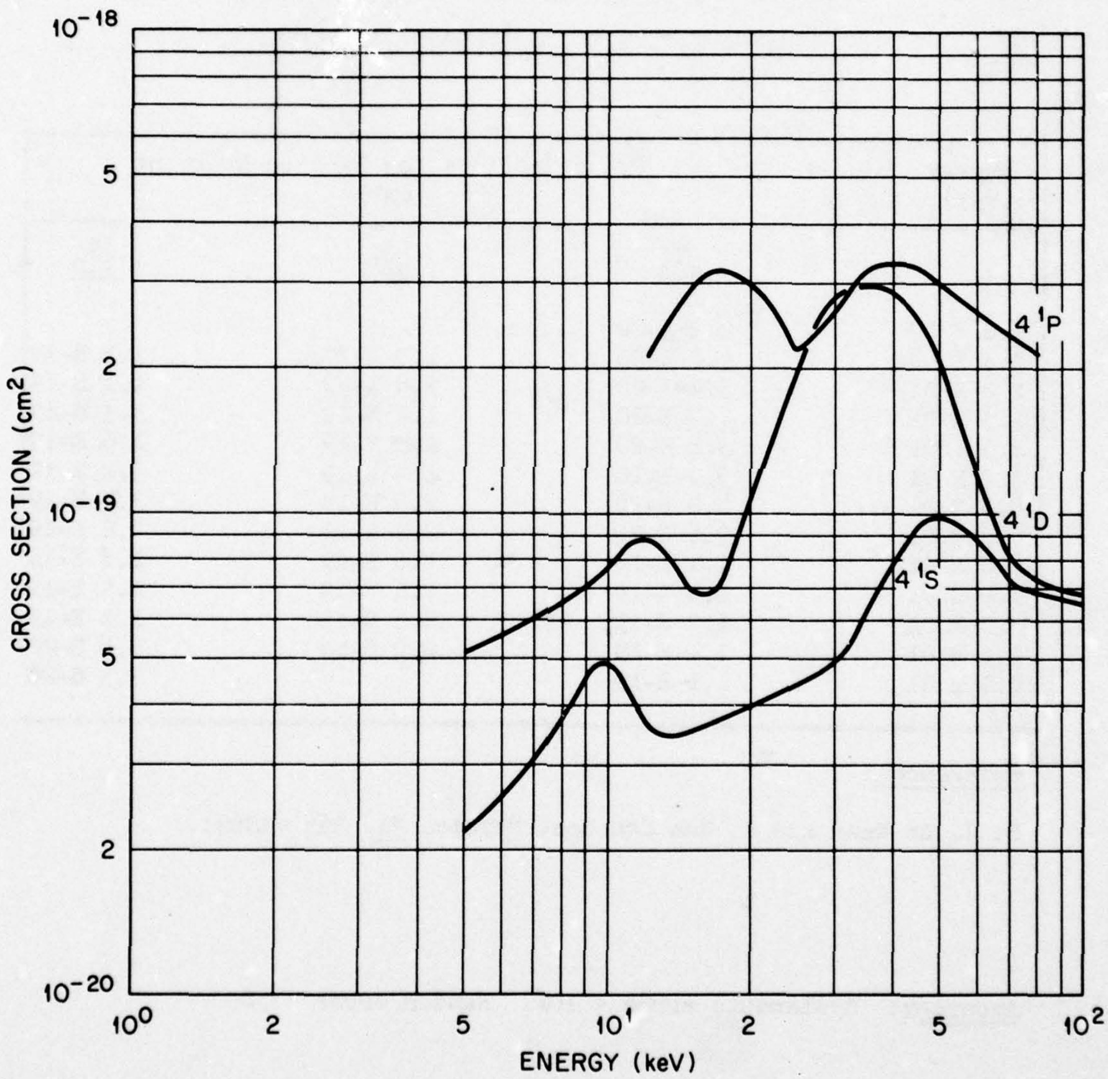
Reference:

F. J. de Heer and J. Van den Bos, Physica 31, 365 (1965).

Accuracy: Systematic error < 10%. Random error < 5%.

Excitation Cross Sections for the Reactions

$He^+ + He \rightarrow He^+ + He^* \ (4^1S,\ 4^1P,\ 4^1D)$



Graphical Data B-2.36.

Tabular Data B-2.37.

Excitation Cross Sections for the Reactions

$$He^{+} + He \rightarrow He^{+} + He^{*} (4^3S, 4^3P, 4^3D)$$

Energy (keV)	Cross Sections for Excited State $n\ell$ (cm^2)		
	4^3S	4^3P	4^3D
5.0 E 00	2.2 E-20		
7.5 E 00	4.0 E-20	1.3 E-20	1.3 E-19
1.0 E 01	3.4 E-20	5.8 E-20	1.1 E-19
1.5 E 01	7.0 E-20	1.2 E-19	1.3 E-19
2.0 E 01	3.2 E-20	1.3 E-19	1.6 E-19
3.0 E 01	5.9 E-20	1.4 E-19	3.2 E-19
4.0 E 01	8.2 E-20	2.0 E-19	3.7 E-19
5.0 E 01	9.6 E-20	2.5 E-19	2.2 E-19
6.0 E 01	1.1 E-19	2.6 E-19	1.8 E-19
7.0 E 01	1.4 E-19	2.5 E-19	1.5 E-19
8.0 E 01	1.2 E-19	2.3 E-19	1.1 E-19
9.0 E 01	1.1 E-19	2.0 E-19	8.8 E-20
10.0 E 01	1.1 E-19		7.5 E-20

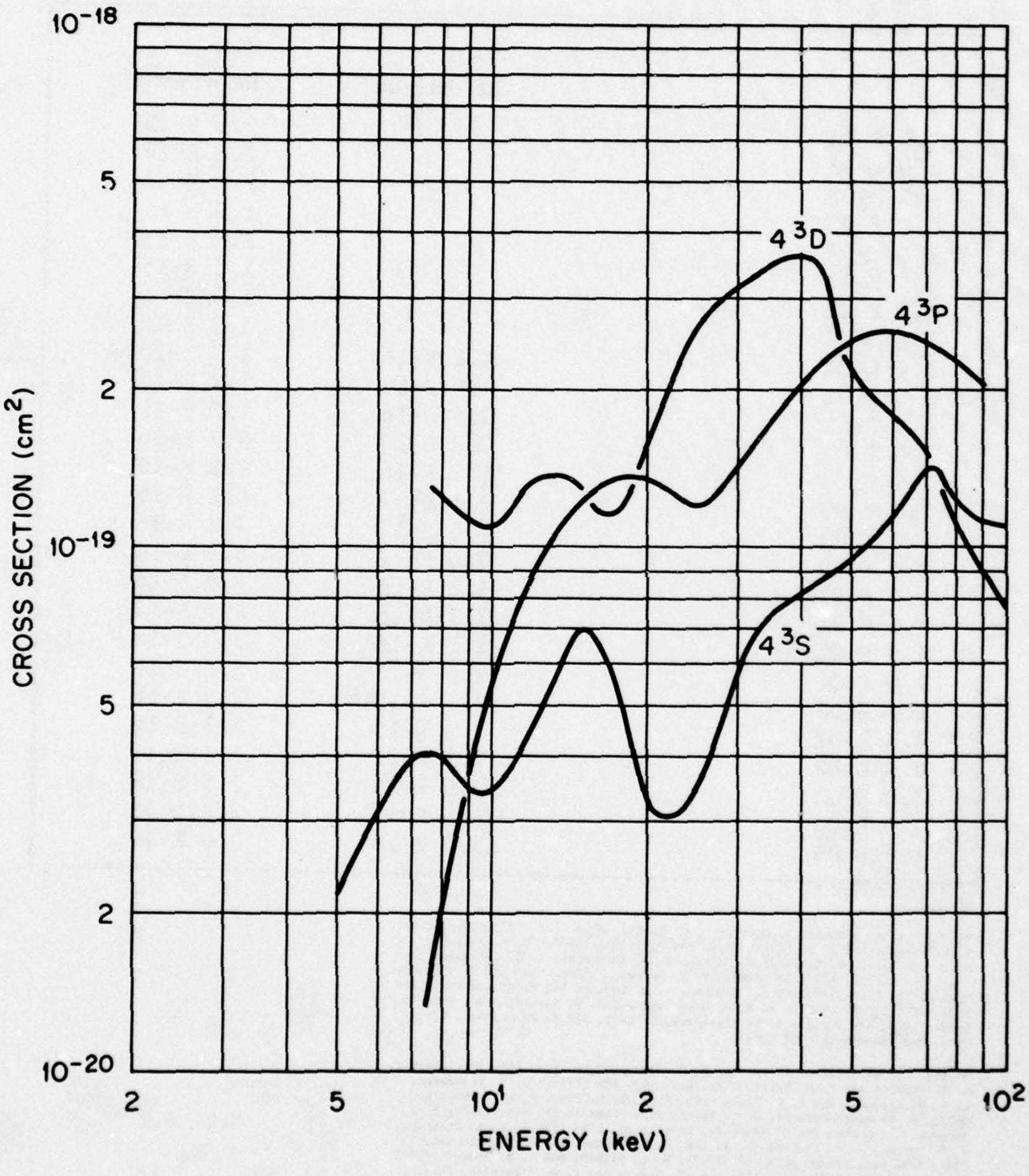
<u>References</u>:

F. J. de Heer and J. Van den Bos, Physica <u>31</u>, 365 (1965).

<u>Accuracy</u>: Systematic error < 10%. Random error < 5%.

Excitation Cross Sections for the Reactions

$He^{+} + He \rightarrow He^{+} + He^{*} (4^3S, 4^3P, 4^3D)$



Graphical Data B-2.38.

Tabular Data B-2.39. Electron capture cross sections for He^+ in H_2 and He.

Energy (keV)	Cross Sections (cm^2)	
	σ_{10} $He^+ + H_2 \rightarrow He^\circ$	σ_{10} $He^+ + He \rightarrow He^\circ$
1.0 E-03		2.5 E-15
2.0 E-03		2.3 E-15
4.0 E-03		2.1 E-15
7.0 E-03		1.9 E-15
1.0 E-02		1.8 E-15
2.0 E-02		1.6 E-15
4.0 E-02		1.4 E-15
7.0 E-02		1.3 E-15
1.0 E-01	1.2 E-16	1.3 E-15
2.0 E-01	1.4 E-16	1.2 E-15
4.0 E-01	1.4 E-16	1.1 E-15
7.0 E-01	1.3 E-16	9.7 E-16
1.0 E 00	1.1 E-16	9.1 E-16
2.0 E 00	7.5 E-17	8.1 E-16
4.0 E 00	7.0 E-17	7.2 E-16
7.0 E 00	9.0 E-17	6.3 E-16
1.0 E 01	1.1 E-16	5.8 E-16
2.0 E 01	1.7 E-16	4.7 E-16
4.0 E 01	2.5 E-16	3.5 E-16
7.0 E 01	2.6 E-16	2.8 E-16
1.0 E 02	2.1 E-16	2.3 E-16
2.0 E 02	1.0 E-16	1.3 E-16
4.0 E 02	2.5 E-17	3.5 E-17
7.0 E 02	5.5 E-18	7.5 E-18
1.0 E 03	1.6 E-18	2.8 E-18
1.6 E 03	3.0 E-19	7.0 E-19

References:

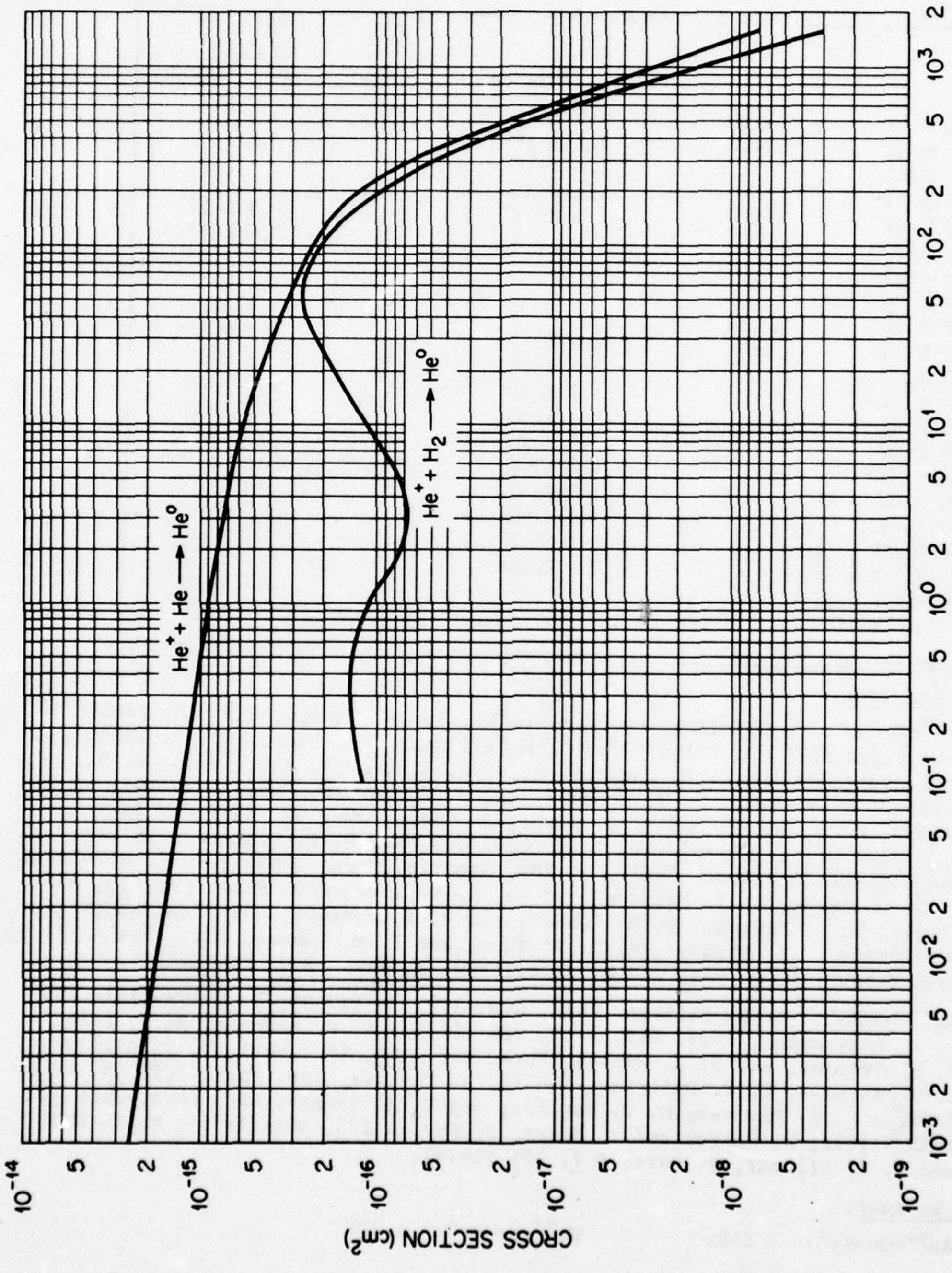
$He^+ + H_2$: S. K. Allison, J. Cuevas, P. G. Murphy, Phys. Rev. 102, 1041 (1956); C. F. Barnett and P. M. Stier, Phys. Rev. 109, 385 (1958); H. B. Gilbody, J. B. Hasted, J. V. Ireland, A. R. Lee, E. W. Thomas and A. S. Whiteman, Proc. Roy. Soc. London, A274, 40 (1963); F. J. DeHeer, J. Schutten and H. Moustafa, Physica 32, 1793 (1966); L. I. Pivovar, V. M. Tubaev, and M. T. Novikov, Sov. Phys.-JETP 14, 20 (1962); J. B. H. Stedeford and J. B. Hasted, Proc. Roy. Soc. London A227, 466 (1955); A. B. Wittkower, G. Levy, and H. B. Gilbody, Proc. Phys. Soc. London 91, 862 (1967).

$He^+ + He$: S. K. Allison, J. Cuevas, P. G. Murphy, Phys. Rev. 102, 1041 (1956); C. F. Barnett and P. M. Stier, Phys. Rev. 109, 385 (1958); N. V. Fedorenko, L. G. Filippenko, and I. P. Flaks, Sov. Phys.-Tech. Phys. 5, 45 (1960); A. Galli, A. Giardini-Guidoni, G. G. Volpi, Nuovo Cimento 26, 845 (1962); F. J. DeHeer, J. Schutten and H. Moustafa, Physica 32, 1793 (1966); H. B. Gilbody, J. B. Hasted, J. V. Ireland, A. R. Lee, E. W. Thomas, and A. S. Whiteman, Proc. Roy. Soc. London A274, 40 (1963); H. B. Gilbody and J. B. Hasted, Proc. Roy. Soc. London A238, 334 (1956); H. C. Hayden and N. G. Utterback, Phys. Rev. 135, A1575 (1964); P. Mahadevan and G. D. Magnuson, Phys. Rev. 171, 103 (1968); L. I. Pivovar, V. M. Tubaev, and M. T. Novikov, Sov. Phys.-JETP 14, 20 (1962); R. F. Potter, J. Chem. Phys. 22, 974 (1954); W. N. Shelton and P. A. Stoycheff, Phys. Rev. A 3, 613 (1971); J. B. H. Stedeford and J. B. Hasted, Proc. Roy. Soc. London A227, 446 (1954).

Accuracy: $He^+ + H_2$: ± 15%
$He^+ + He$: ± 15%

Electron Capture Cross Sections for

He^+ in H_2 and He



Graphical Data B-2.40.

Tabular Data B-2.41.
Electron Capture Cross Sections for He^{++} in He

Energy (keV)	Cross Sections (cm^2)	
	σ_{20} $He^{++} + He \rightarrow He^{\circ}$	σ_{21} $He^{++} + He \rightarrow He^{+}$
6.0 E-02	4.0 E-16	
1.0 E-01	3.2 E-16	
2.0 E-01	2.6 E-16	
4.0 E-01	2.2 E-16	
7.0 E-01	2.0 E-16	1.3 E-17
1.0 E 00		1.6 E-17
2.0 E 00		2.1 E-17
5.0 E 00		3.2 E-17
7.5 E 00		3.9 E-17
1.0 E 01	1.6 E-16	4.5 E-17
2.0 E 01	1.5 E-16	7.1 E-17
5.0 E 01	1.2 E-16	1.8 E-16
7.5 E 01	1.1 E-16	2.7 E-16
1.0 E 02	9.0 E-17	3.3 E-16
2.0 E 02	4.0 E-17	2.4 E-16
5.0 E 02	5.1 E-18	7.0 E-17
7.5 E 02	9.5 E-19	3.3 E-17
1.0 E 03	2.6 E-19	2.0 E-17
1.4 E 03	3.6 E-20	6.0 E-18
3.0 E 03		3.0 E-19
6.8 E 03		7.3 E-20

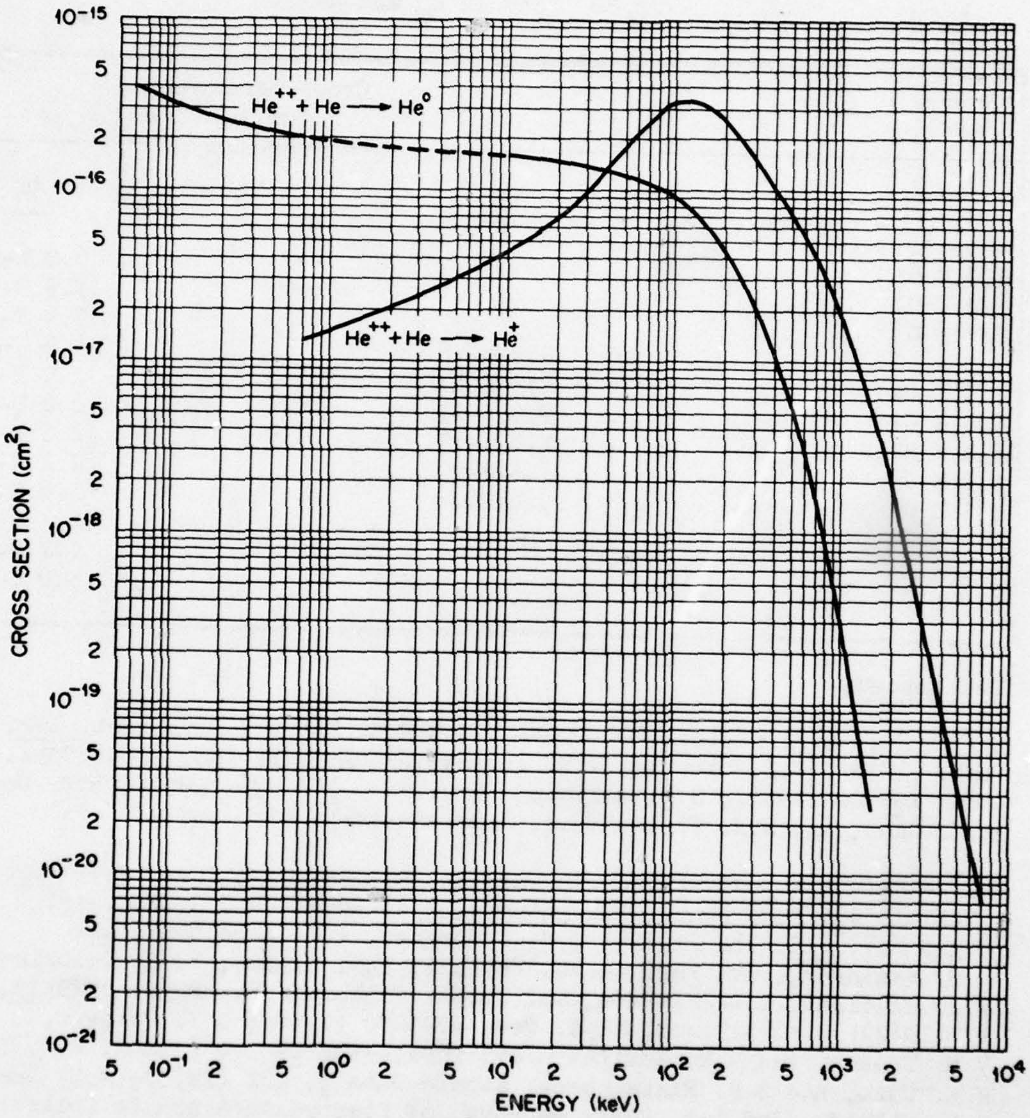
References:

$He^{++} + He \rightarrow He^{+}$: V.V. Afrosimov, G.A. Leĭko, Yu. A. Mamaev, and M.N. Panov, Sov. Phys.-JETP 40, 661 (1975); S. K. Allison, Phys. Rev. 109, 76 (1958); J. E. Bayfield and G. A. Khayrallah, Phys. Rev. A 11, 920 (1975); K. H. Berkner, R. V. Pyle, J. W. Stearns, and J. C. Warren, Phys. Rev. 166, 44 (1968); G. R. Hertel and W. S. Koski, J. Chem. Phys. 40, 3452 (1964); P. Hvelplund, J. Heinemeier, E. H. Pedersen, and F. R. Simpson, 9th Int. Conf. Elect. and Atom. Coll., p. 185, Seattle, Wash. (1975); V. S. Nikolaev, I. S. Dmitriev, L. N. Fateeva, and Ya. A. Teplova, Sov. Phys.-JETP 13, 695 (1961); L. I. Pivovar, V. M. Tubaev, and M. T. Novikov, Sov. Phys.-JETP 14, 20 (1962); L. I. Pivovar, M. T. Novikov, and V. M. Tubaev, Soc. Phys.-JEPT 15, 1035 (1962); M. B. Shah and H. B. Gilbody, J. Phys. B 7, 256 (1974).

$He^{++} + He \rightarrow He^{\circ}$: S. K. Allison, Phys. Rev. 109, 76 (1958); J. E. Bayfield and G. A. Khayrallah, Phys. Rev. A 11, 920 (1975); K. H. Berkner, R. V. Pyle, J. W. Stearns, and J. C. Warren, Phys. Rev. 166, 44 (1968); V. S. Nikolaev, L. N. Fateeva, I. S. Dmitriev, and Ya. A. Teplova, Sov. Phys.-JETP 14, 67 (1962); L. I. Pivovar, M. T. Novikov, and V. M. Tubaev, Soc. Phys.-JETP 15, 1035 (1962); H. Schrey and B. Huber, Z. Phy. A 273, 401 (1975); M. B. Shah and H. B. Gilbody, J. Phys. B 7, 256 (1974).

Accuracy:

$He^{++} + He \rightarrow He^{+}$: ± 25%. $He^{++} + He \rightarrow He^{\circ}$: ± 20%.



Graphical Data B-2.42.

Electron Capture Cross Sections for He^{++} in He

Tabular Data B-2.43.

Cross Sections for One Electron Loss

of He^+ Ions in H_2 and He

Energy (keV)	Cross Sections (cm^2)	
	H_2	He
2.0 E 01		6.0 E-19
5.0 E 01		1.9 E-18
8.0 E 01		3.4 E-18
1.0 E 02	2.4 E-18	4.4 E-18
2.0 E 02	1.1 E-17	1.0 E-17
5.0 E 02	2.0 E-17	2.2 E-17
8.0 E 02	1.8 E-17	2.3 E-17
1.0 E 03	1.5 E-17	2.2 E-17
1.5 E 03	9.6 E-18	1.8 E-17
2.0 E 03		1.4 E-17
4.0 E 03		7.7 E-18
6.0 E 03		5.2 E-18

References:

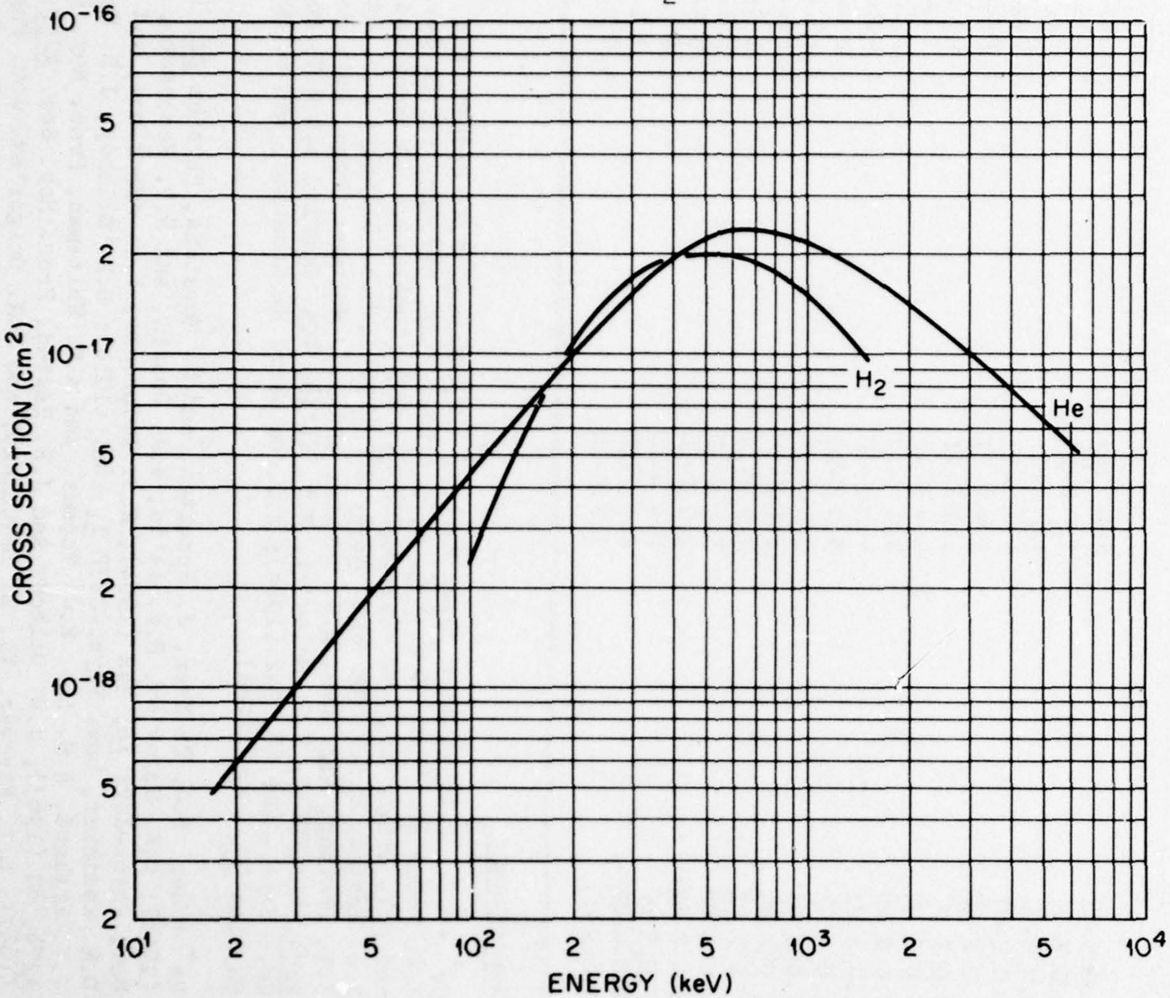
$He^+ + H_2$: S.K. Allison, J. Cuevas, and P.G. Murphy, Phys. Rev. 102, 1041 (1956); L.I. Pivovar, V.M. Tubaev, and M.T. Novikov, Sov. Phys.-JETP 14, 20 (1962); S.K. Allison, Phys. Rev. 109, 76 (1958); R.C. Dehmel, H.K. Chau, and H.H. Fleischmann, Atomic Data 5, 231 (1973).

He^+ + He: S.K. Allison, J. Cuevas, and P.G. Murphy, Phys. Rev. 102, 1041 (1956); P.R. Jones, F.P. Ziemba, H.A. Moses, and E. Everhart, Phys. Rev. 113, 182 (1959); N.V. Fedorenko, V.V. Afrosimov, and D.M. Kaminker, Sov. Phys.-Tech. Phys. 1, 1861 (1956); I. S. Dmitriev, V.S. Nikolaev, L.N. Fateeva, and Ya. A. Teplova, Sov. Phys.-JETP 15, 11 (1962); S.K. Allison, Phys. Rev. 109, 76 (1958); L.I. Pivovar, V.M. Tubaev, and M.T. Novikov, Sov. Phys.-JETP 14, 20 (1962); R.C. Dehmel, H.K. Chau, and H.H. Fleischmann, Atomic Data 5, 231 (1973); A.R. Lee and H.B. Gilbody, 3rd Int. Conf. on Phys. of Electronic & Atomic Collisions (London, 1963) North-Holland Publishing Co. (Amsterdam) p. 692 (1964).

Graphical Data B-2.44.

Cross Sections for One Electron Loss

of He^+ Ions in H_2 and He



Tabular Data B-2.45.

Cross sections for the production of slow electrons by He^+ ions in H_2 and He.

Energy (keV)	Cross Sections (cm^2) H_2	He
1.0 E-01	2.2 E-17	2.4 E-17
2.0 E-01	3.7 E-17	2.5 E-17
5.0 E-01	4.1 E-17	2.7 E-17
7.0 E-01	4.0 E-17	2.8 E-17
1.0 E 00	3.9 E-17	2.9 E-17
2.0 E 00	3.9 E-17	3.2 E-17
5.0 E 00	4.0 E-17	3.8 E-17
7.0 E 00	4.0 E-17	4.1 E-17
1.0 E 01	4.0 E-17	4.4 E-17
2.0 E 01	5.0 E-17	5.2 E-17
5.0 E 01	1.2 E-16	7.3 E-17
7.0 E 01	1.7 E-16	8.6 E-17
1.0 E 02	2.4 E-16	1.1 E-16
2.0 E 02	3.5 E-16	1.8 E-16
5.0 E 02	2.8 E-16	1.8 E-16
7.0 E 02	2.4 E-16	1.6 E-16
1.0 E 03	2.1 E-16	1.3 E-16
1.8 E 03	1.5 E-16	9.0 E-17

References:

$He^+ + H_2$: R.A. Langley, D.W. Martin, D.S. Harmer, J.W. Hooper, and E.W. McDaniel, Phys. Rev. 136, A379 (1964); L.I. Pivovar, Yu. Z. Levchenko, and A.N. Grigor'ev, Sov. Phys.-JETP 27, 699 (1968); H.B. Gilbody and J.B. Hasted, Proc. Roy. Soc. A240, 382 (1957); H.B. Gilbody, J.B. Hasted, J.V. Ireland, A.R. Lee, E.W. Thomas, and A.S. Whitman, Proc. Roy. Soc. A274, 40 (1963); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Sov. Phys.-JETP 18, 342 (1964); F.J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1793 (1966).

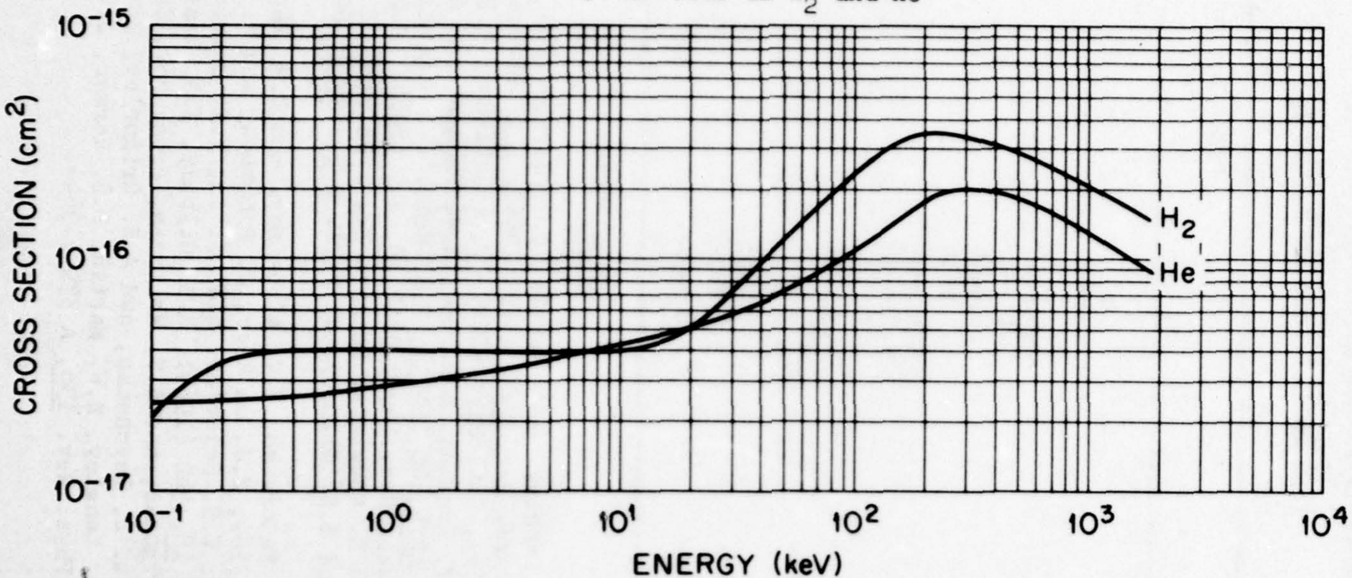
He^+ + He: F.J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1793 (1966); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Sov. Phys.-JETP 18, 342 (1964); N.V. Fedorenko, V.V. Afrosimov, and D.M. Kaminker, Sov. Phys.-JETP 1, 1861 (1956); H.B. Gilbody, J.B. Hasted, J.V. Ireland, A.R. Lee, E.W. Thomas, and A.S. Whiteman, Proc. Roy. Soc. A274, 40 (1963); H.B. Gilbody and J.B. Hasted, Proc. Roy. Soc. A240, 382 (1957); L.I. Pivovar, Yu. Z. Levchenko, and A.N. Grigor'ev, Sov. Phys.-JETP 27, 699 (1968); R.A. Langley, D.W. Martin, D.S. Harmer, J.W. Hooper, and E.W. McDaniel, Phys. Rev. 136, A379 (1964).

Accuracy: ± 25%.

Graphical Data B-2.46.

Cross Sections for the Production of Slow

Electrons by He^{+} Ions in H_2 and He



Tabular Data B-2.47.

Cross Sections for the Production of Positive

Ions by He^+ Ions in H_2 and He

Energy (keV)	Cross Sections (cm^2) H_2	He
3.0 E 00	1.3 E-16	
5.0 E 00	1.1 E-16	
7.0 E 00	1.2 E-16	
1.0 E 01	1.5 E-16	5.6 E-16
2.0 E 01	2.2 E-16	5.4 E-16
5.0 E 01	4.0 E-16	4.2 E-16
7.0 E 01	4.7 E-16	3.8 E-16
1.0 E 02	5.3 E-16	3.4 E-16
2.0 E 02	4.5 E-16	2.7 E-16
5.0 E 02	2.8 E-16	1.8 E-16
7.0 E 02	2.3 E-16	1.4 E-16
1.0 E 03	1.8 E-16	1.1 E-16
1.8 E 03	1.3 E-16	0.8 E-16

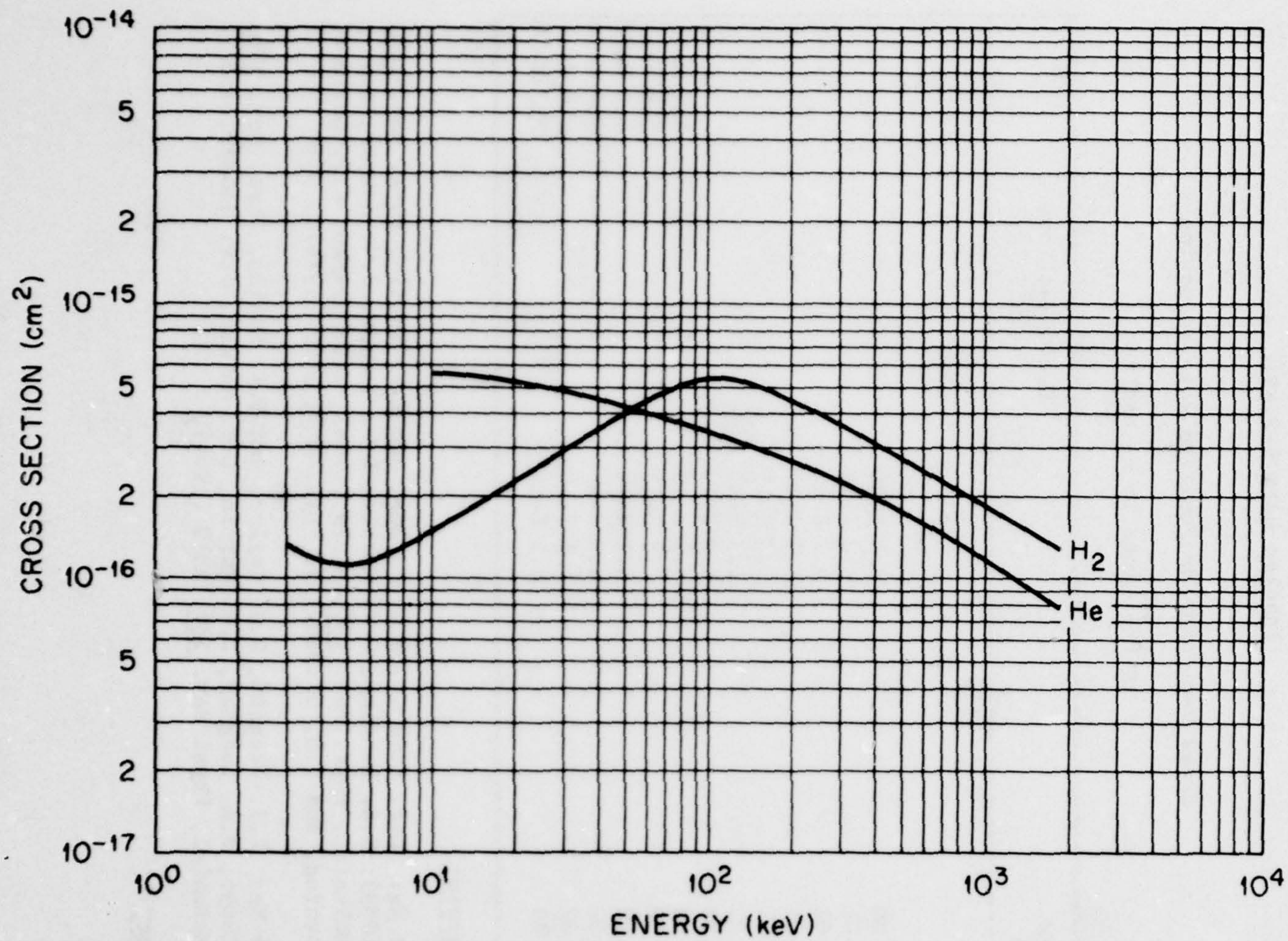
References:

$He^+ + H_2$: R.A. Langley, D.W. Martin, D.S. Harmer, J.W. Hooper, and E.W. McDaniel, Phys. Rev. 136, A379 (1964); L.I. Pivovar, Yu. Z. Levchenko, and A.N. Grigor'ev, Sov. Phys.-JETP 27, 699 (1968); H.B. Gilbody, J.B. Hasted, J.V. Ireland, A.R. Lee, E.W. Thomas, and A.S. Whiteman, Proc. Roy. Soc. A274, 40 (1963); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Sov. Phys.-JETP 18, 342 (1964); F.J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1793 (1966); R. Browning, C.J. Latimer, and H.B. Gilbody, J. Phys. B 2, 534 (1969).

He^+ + He: N.V. Fedorenko, V.V. Afrosimov, and D.M. Kaminker, Sov. Phys.-JETP 1, 1861 (1956); F.J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1793 (1966); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Sov. Phys.-JETP 18, 342 (1964); H.B. Gilbody, J.B. Hasted, J.V. Ireland, A.R. Lee, E.W. Thomas, and A.S. Whiteman, Proc. Roy. Soc. A274, 40 (1963); L.I. Pivovar, Yu. Z. Levchenko, and A.N. Grigor'ev, Sov. Phys.-JETP 27, 699 (1968); R.A. Langley, D.W. Martin, D.S. Harmer, J.W. Hooper, and E.W. McDaniel, Phys. Rev. 136, A 379 (1964).

Accuracy:

$\pm$ 25%.



Graphical Data B-2.48.

Cross Sections for the Production of Positive Ions by He^+ Ions in H_2 and He

Tabular Data B-2.49.

Cross Sections for Positive Ion Production

by He^{++} Ions in H_2 and He

Energy (keV)	Cross Sections (cm^2) H_2	He
6.8 E 00	3.1 E-16	
1.0 E 01	4.2 E-16	
2.0 E 01	6.8 E-16	
4.0 E 01	1.2 E-15	
6.0 E 01	1.3 E-15	
8.0 E 01	1.3 E-15	
1.0 E 02	1.3 E-15	
1.5 E 02	1.3 E-15	5.7 E-16
2.0 E 02	1.2 E-15	5.4 E-16
4.0 E 02	8.1 E-16	4.0 E-16
6.0 E 02	6.3 E-16	3.2 E-16
8.0 E 02	5.1 E-16	2.6 E-16
1.0 E 03	4.5 E-16	2.3 E-16

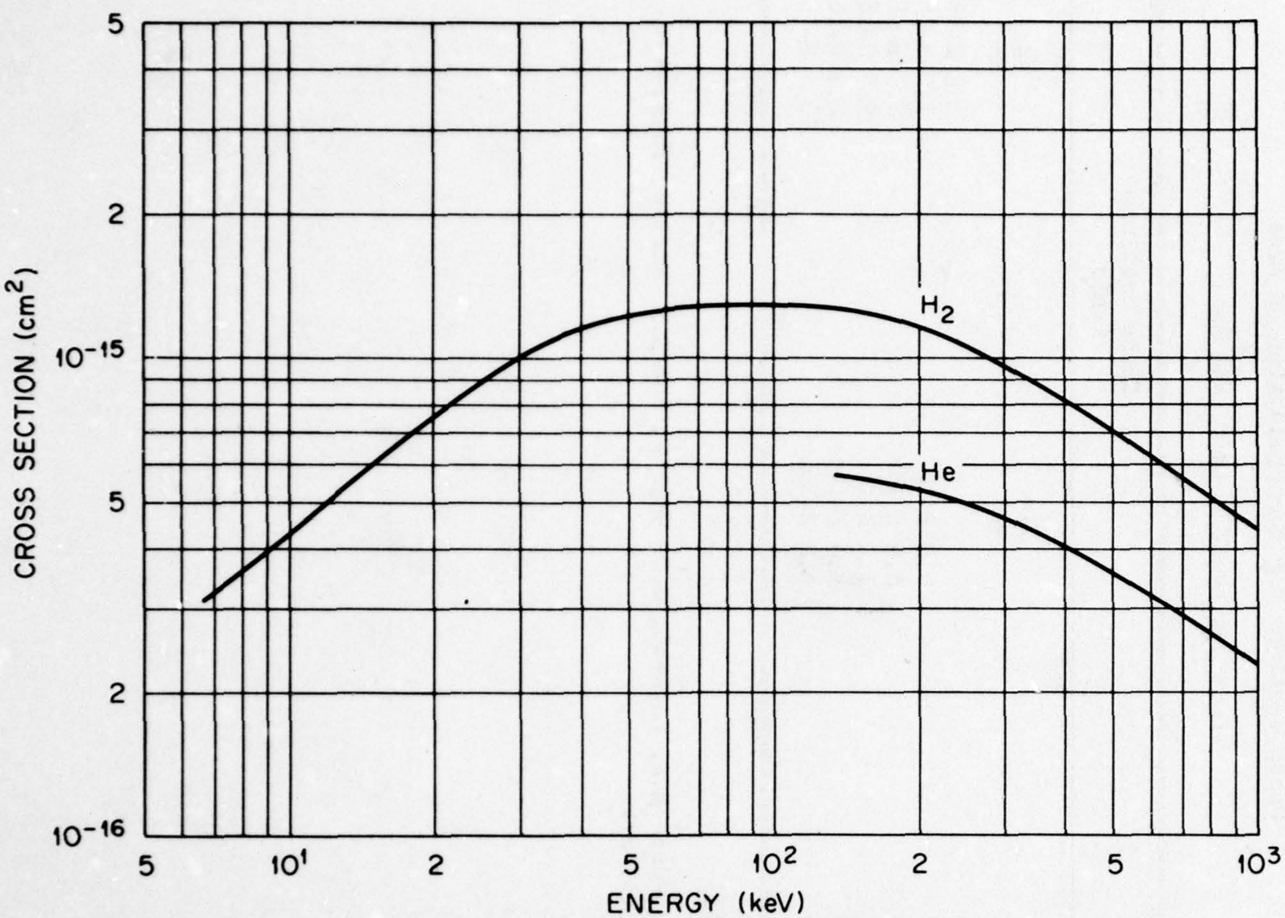
References:

$He^{++} + H_2$: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969); R.A. Langley, D.W. Martin, D.S. Harmer, J.W. Hooper, and E.W. McDaniel, Phys. Rev. 136, A 379 (1964); W.G. Graham, C.J. Latimer, R. Browning, and H.B. Gilbody, J. Phys. B 7, L405 (1974).

He^{++} + He: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969); R.A. Langley, D.W. Martin, D.S. Harmer, J.W. Hooper, and E.W. McDaniel, Phys. Rev. 136, A379 (1964).

Accuracy:

± 20%.



Graphical Data B-2.50.

Cross Sections for Positive Ion Production

by He^{++} Ions in H_2 and He

Tabular Data B-2.51.

Cross Sections for the Production of Free

Electrons by He^{++} in H_2 and He

Energy (keV)	Cross Sections (cm^2) H_2	He
1.8 E 02		1.3 E-16
2.0 E 02	6.3 E-16	1.5 E-16
4.0 E 02	6.9 E-16	2.5 E-16
6.0 E 02	5.9 E-16	2.5 E-16
8.0 E 02	4.9 E-16	2.3 E-16
1.0 E 03	4.2 E-16	2.1 E-16

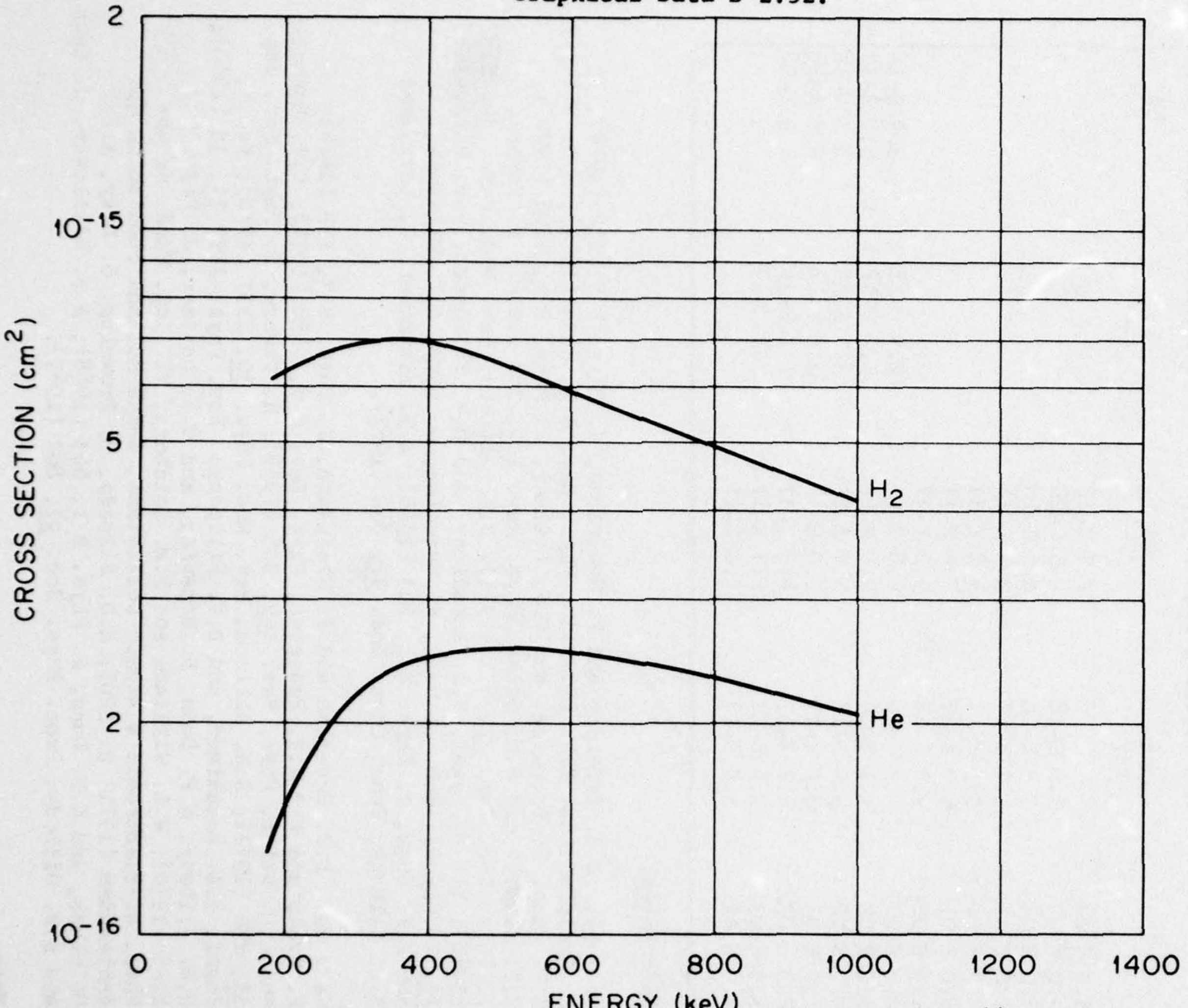
References:

He^{++} + H_2, He: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969).

Accuracy:

± 20%.

Graphical Data B-2.52.



Cross Sections for the Production of Free Electrons by He^{++} in H_2 and He

Tabular Data B-2.53.

Cross sections for one and two electron loss for He atoms in H_2 and He.

Energy (keV)	Cross Sections (cm^2)			
	One Electron Loss (σ_{01})		Two Electron Loss (σ_{02})	
	H_2	He	H_2	He
3.0 E 00		2.7 E-18		
4.0 E 00	5.0 E-18	4.5 E-18		
5.0 E 00	7.3 E-18	8.0 E-18		
1.0 E 01	1.7 E-17	2.3 E-17		
2.0 E 01	3.3 E-17	4.2 E-17		
5.0 E 01	6.0 E-17	7.0 E-17		
1.0 E 02	9.0 E-17	9.2 E-17		
2.0 E 02	1.2 E-16	9.8 E-17	2.5 E-18	3.9 E-18
5.0 E 02	1.1 E-16	9.0 E-17	5.0 E-18	5.2 E-18
8.0 E 02	9.4 E-17	7.7 E-17	3.7 E-18	3.7 E-18
1.0 E 03	8.2 E-17	7.0 E-17	2.8 E-18	2.8 E-18
2.0 E 03	5.1 E-17	4.3 E-17	1.1 E-18	1.3 E-18
3.0 E 03	3.8 E-17	2.7 E-17	7.4 E-19	
4.0 E 03	3.0 E-17	2.0 E-17		

References:

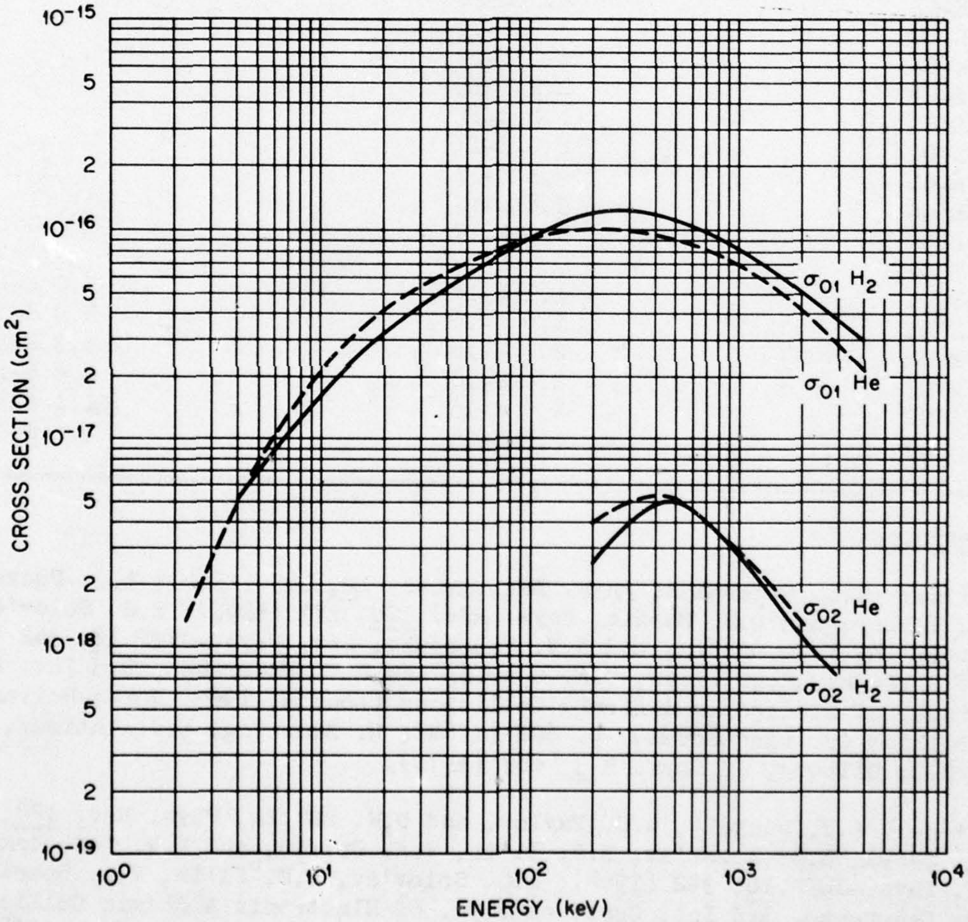
He + H_2: E.H. Pedersen and P. Hvelplund, J. Phys. B 7, 132 (1974); P. Hvelplund and E.H. Pedersen, Phys. Rev. A 9, 2434 (1974); H.B. Gilbody, K.F. Dunn, R. Browning, and C.J. Latimer, J. Phys. B 3, 1105 (1970); C.F. Barnett and P.M. Stier, Phys. Rev. 109, 385 (1958); H. Tawara, J. Phys. Soc. Jap. 31, 871 (1971); S.K. Allison, Rev. Mod. Phys. 30, 1137 (1958); Ya. M. Fogel, V.A. Ankudinov, and D.V. Pilipenko, Sov. Phys.-JETP 11, 18 (1960); H.B. Gilbody, R. Browning, G. Levy, A.I. McIntosh, and K.F. Dunn, J. Phys. B 1, 863 (1968); A.B. Wittkower, G. Levy, and H.B. Gilbody, Proc. Phys. Soc. 91, 862 (1967).

He + He: E.H. Pedersen and P. Hvelplund, J. Phys. B 7, 132 (1974); P. Hvelplund and E.H. Pedersen, Phys. Rev. A 9, 2434 (1974); C.F. Barnett and P.M. Stier, Phys. Rev. 109, 385 (1958); H. Tawara, J. Phys. Soc. Jap. 31, 236 (1971); S.K. Allison, Rev. Mod. Phys. 30, 1137 (1958); Ya. M. Fogel, V.A. Ankudinov, and D.V. Pilipenko, Sov. Phys.-JETP 11, 18 (1960); H.B. Gilbody, K.F. Dunn, R. Browning, and C.J. Latimer, J. Phys. B 3, 1105 (1970); W.L. Williams and F.M. Goldberg, VII Int. Conf. on the Phys. of Electronic & Atomic Collisions, North Holland Publishing Co. Amsterdamm (1971) p. 1087; H.B. Gilbody, R. Browning, G. Levy, A.I. McIntosh, and K.F. Dunn, J. Phys. B 1, 863 (1968); A.B. Wittkower, G. Levy, and H.B. Gilbody, Proc. Phys. Soc. 91, 862 (1967).

Note:

Measurements made before 1970 did not properly take into account the presence of He metastable states.

Accuracy: ± 25%.



Graphical Data B-2.54.

Cross Sections for One and Two Electron Loss

for He Atoms in H_2 and He

Tabular Data B-2.55.

Cross Sections for Ionization of H_2 and He by He Atoms

Energy (keV)	Cross Sections (cm^2) H_2	He
4.6 E-02	2.5 E-20	
5.0 E-02	3.5 E-19	
7.0 E-02	6.0 E-19	
1.0 E-01	2.2 E-18	
2.0 E-01	1.0 E-17	
5.0 E-01	2.9 E-17	
9.0 E-01	4.3 E-17	
3.0 E 00	3.8 E-17	
5.0 E 00	5.0 E-17	
1.0 E 01	7.7 E-17	
2.0 E 01	1.1 E-16	5.0 E-17
5.0 E 01	1.8 E-16	8.4 E-17
1.0 E 02	2.4 E-16	1.3 E-16
2.0 E 02	2.6 E-16	1.4 E-16
5.0 E 02	1.9 E-16	1.1 E-16
1.0 E 03	1.2 E-16	7.3 E-17

References:

He + H_2: N.G. Utterback, Phys. Rev. Letts. 12, 295 (1964); L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Sov. Phys.-JETP 18, 342 (1964); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, 3rd Int. Conf. on Phys. of Electronic & Atomic Collisions (London, 1963) North-Holland Publishing Co. (Amsterdam) p. 692 (1964); R. Browning, C.J. Latimer, and H.B. Gilbody, J. Phys. B 3, 667 (1970).

He + He: L.J. Puckett, G.O. Taylor, and D.W. Martin, Phys. Rev. 178, 271 (1969); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, Sov. Phys.-JETP 18, 342 (1964); E.S. Solov'ev, R.N. Il'in, V.A. Oparin, and N.V. Fedorenko, 3rd Int. Conf. on Phys. of Electronic & Atomic Collisions (London, 1963) North-Holland Publishing Co. (Amsterdam) p. 692 (1964).

Accuracy:

$\pm$ 25%.

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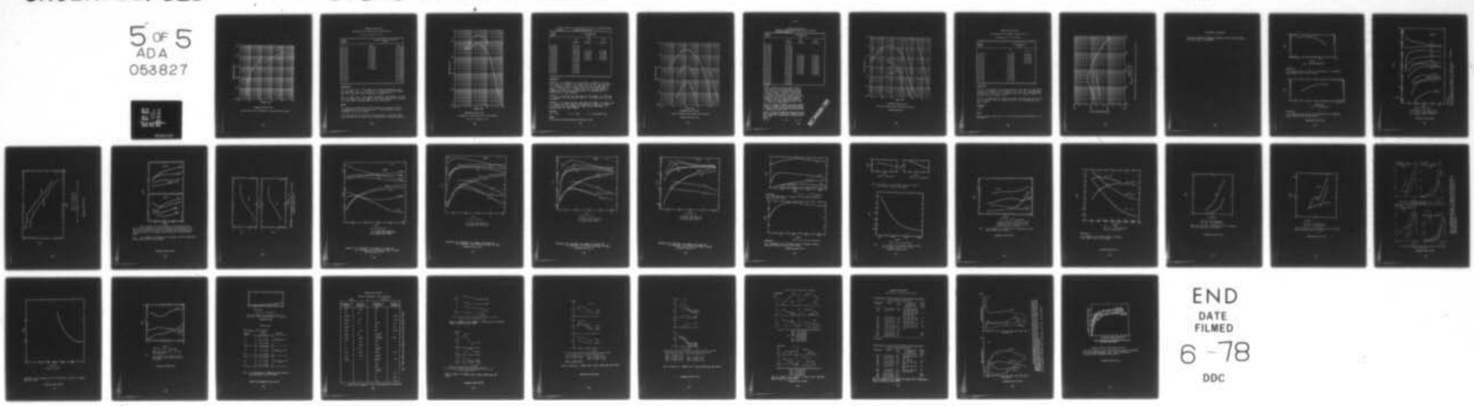

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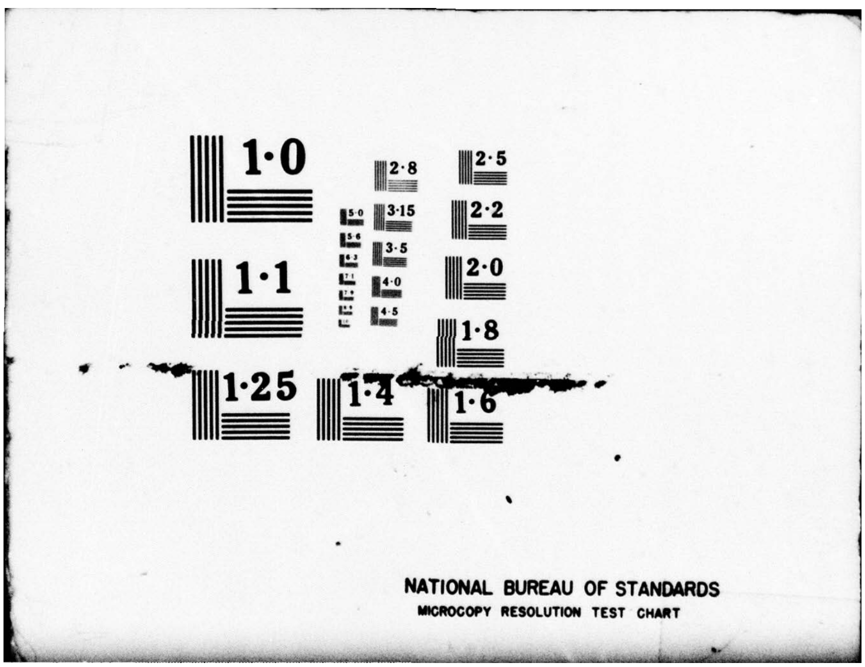
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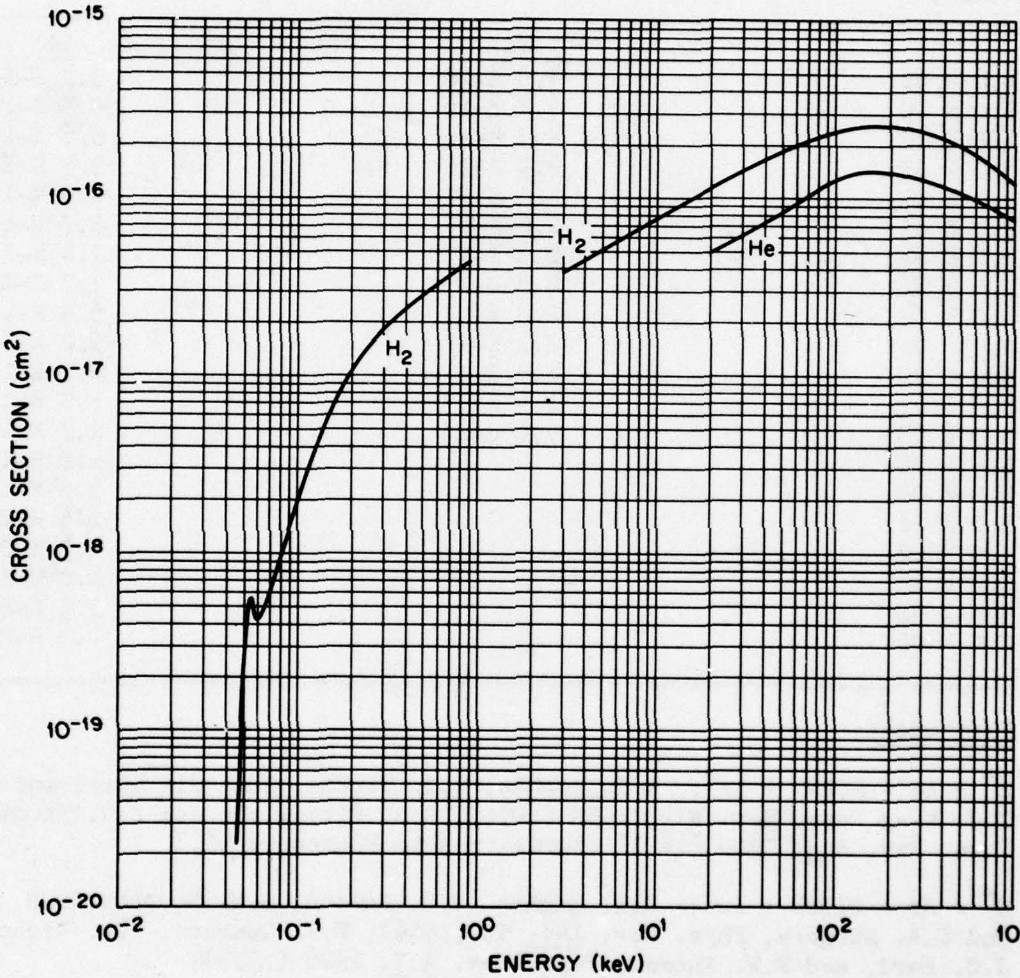


Graphical Data B-2.56.

Cross Sections for Ionization of H_2 and He by He Atoms

Tabular Data B-2.57.

Excitation Cross Sections for the Reactions

$H^+ + Ar \rightarrow H(2s,3s) + Ar^+$

Energy (keV)	Cross Sections for State $n\ell$ (cm^2)	
	2s	3s
4.0 E 00	4.8 E-18	3.3 E-18
5.0 E 00	3.7 E-18	3.7 E-18
6.0 E 00	4.3 E-18	3.6 E-18
8.0 E 00	6.9 E-18	3.5 E-18
1.0 E 01	1.0 E-17	4.0 E-18
1.5 E 01	2.0 E-17	5.7 E-18
2.0 E 01	2.3 E-17	7.4 E-18
3.0 E 01	2.3 E-17	7.7 E-18
4.0 E 01	2.3 E-17	6.4 E-18
5.0 E 01	2.1 E-17	5.2 E-18
6.0 E 01	1.9 E-17	4.5 E-18
8.0 E 01	1.4 E-17	3.5 E-18
1.0 E 02	9.6 E-18	2.7 E-18
1.5 E 02		1.0 E-18
2.0 E 02		3.5 E-19
3.0 E 02		6.0 E-20
4.0 E 02		1.7 E-20
5.0 E 02		6.0 E-21
6.0 E 02		5.1 E-21
7.0 E 02		4.2 E-21

References:

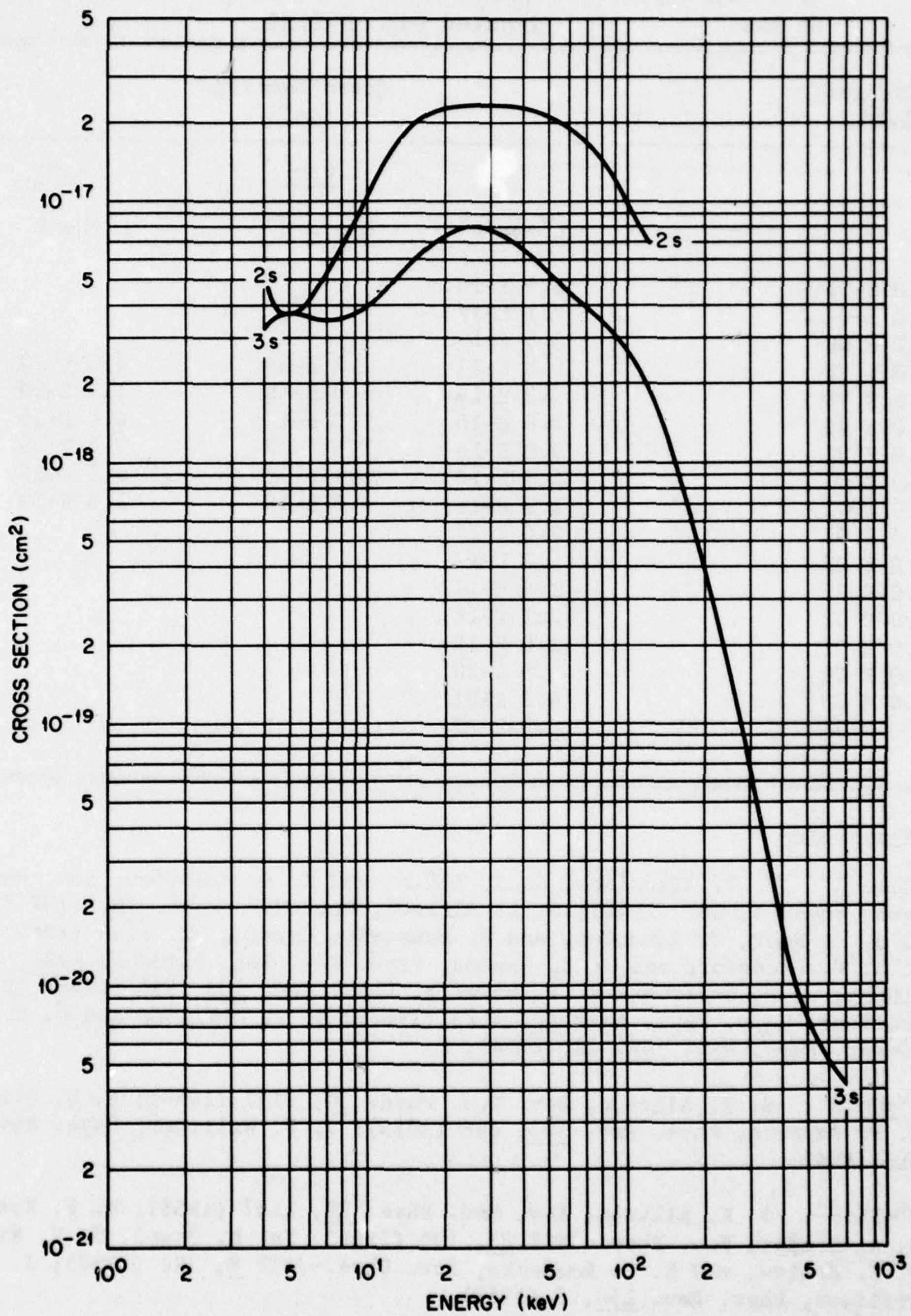
$H^+ + Ar \rightarrow H(2s) + Ar^+$: R.H. Hughes, E.D. Stokes, Song-Sik Choe, and T.J. King Phys. Rev. A 4, 1453 (1971); R.L. Fitzwilson and E.W. Thomas, Phys. Rev. A 3, 1305 (1971) [normalized to Hughes et al.].

$H^+ + Ar \rightarrow H(3s) + Ar^+$: R.H. Hughes, H.R. Dawson, B.M. Doughty, D.B. Kay, and C.A. Stigers, Phys. Rev. 146, 53 (1966); R.J. Conrads, T.W. Nichols, J.C. Ford, and E.W. Thomas, Phys. Rev. A 7, 1928 (1973).

Notes:

It is generally found that the cross section for formation of H(ns) at energies above 80 keV decreases as n^{-3}; this rule may be used to extrapolate to other ns levels.

Some measurements with incident D^+ are available. In general these cross sections are the same as for H^+ projectiles of the same velocity.



Graphical Data B-2.58.

Excitation Cross Sections for the Reactions

$H^{+} + Ar \rightarrow H(2s,3s) + Ar^{+}$

Electron capture cross sections for H^+ and H° passing through Ne gas. Tabular Data B-2.59.

Energy (keV)	Cross Sections (cm^2)		
	σ_{10}	σ_{0-1}	σ_{1-1}
	$H^+ + Ne \rightarrow H^\circ$	$H^\circ + Ne \rightarrow H^-$	$H^+ + Ne \rightarrow H^-$
4.0 E-01	8.6 E-18		
7.0 E-01	2.1 E-17		
1.0 E 00	3.5 E-17		
2.0 E 00	8.8 E-17	1.7 E-18	4.3 E-20
4.0 E 00	1.8 E-16	6.0 E-18	1.7 E-19
7.0 E 00	2.8 E-16	1.3 E-17	4.4 E-19
1.0 E 01	3.0 E-16	1.5 E-17	7.2 E-19
2.0 E 01	2.3 E-16	1.1 E-17	6.0 E-19
4.0 E 01	1.3 E-16	4.5 E-18	1.5 E-19
7.0 E 01	7.6 E-17		
1.0 E 02	4.7 E-17		
2.0 E 02	1.4 E-17		
4.0 E 02	2.1 E-18		
7.0 E 02	2.6 E-19		
1.0 E 03	5.0 E-20		
2.0 E 03	4.2 E-21		
4.0 E 03	3.2 E-22		

References:

$H^+ + Ne \rightarrow H^\circ$: V. V. Afrosimov, R. N. Il'in, and E. S. Solov'ev, Sov. Phys.-Tech. Phys. 5, 661 (1960); S. K. Allison, Rev. Mod. Phys. 30, 1137 (1958); F. J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1766 (1966); J. B. H. Stedeford and J. B. Hasted, Proc. Roy. Soc. (London) A227, 466 (1955); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956); U. Schryber, Helv. Phys. Acta 40, 1023 (1967); J. F. Williams and D. N. F. Dunbar, Phys. Rev. 149, 62 (1966).

$H^\circ + Ne \rightarrow H^-$: S. K. Allison, Rev. Mod. Phys. 30, 1137 (1958); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956); J. F. Williams, Phys. Rev. 153, 116 (1967).

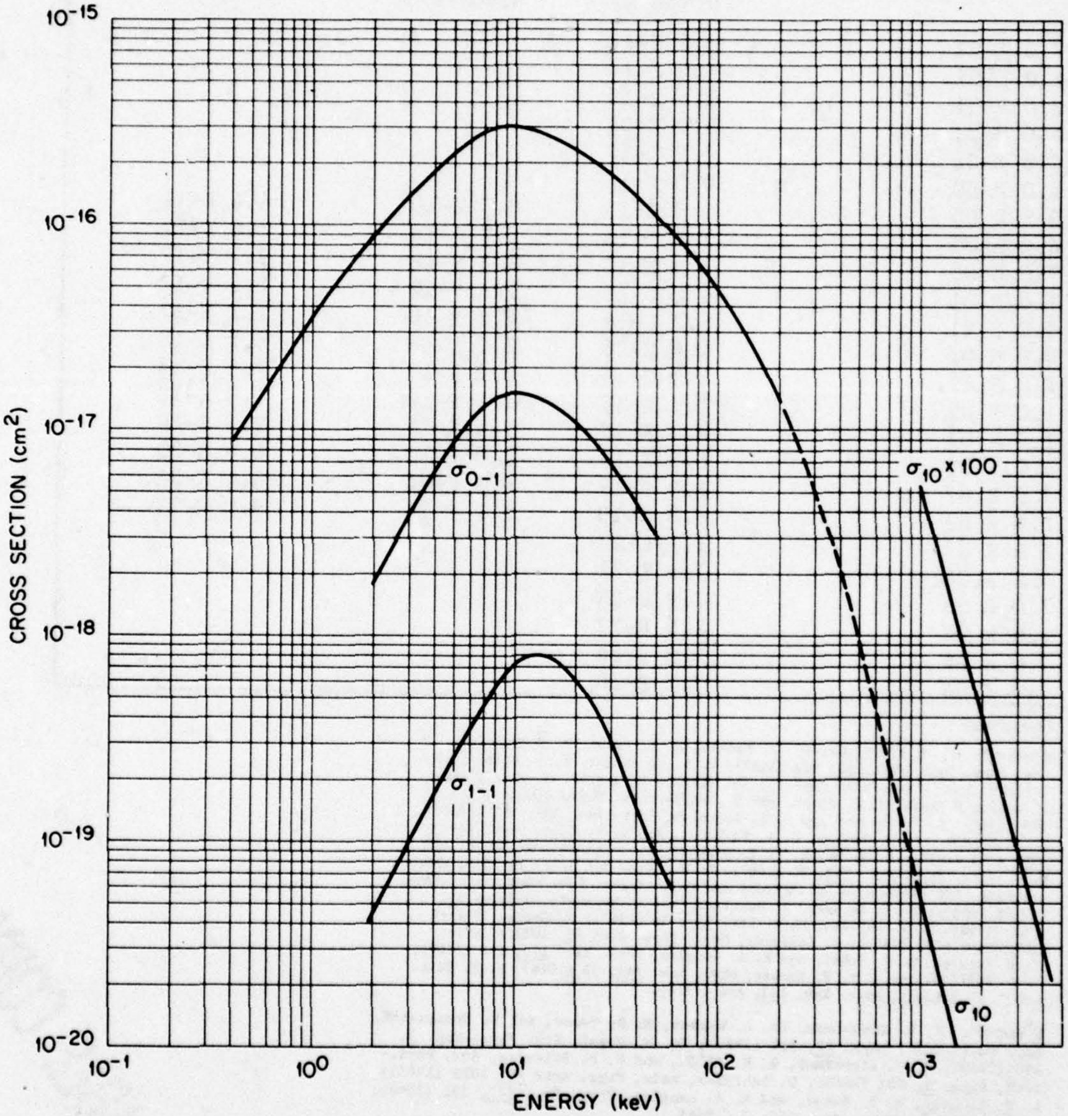
$H^+ + Ne \rightarrow H^-$: S. K. Allison, Rev. Mod. Phys. 30, 1137 (1958); V. F. Kozlow and S. A. Bondar, Sov. Phys.-JETP 23, 195 (1966); Ya. M. Fogel, R. V. Mitin, V. F. Kozlow, and N. D. Romashko, Sov. Phys.-JETP 8, 390 (1959); J. F. Williams, Phys. Rev. 150, 7 (1966).

Accuracy:

σ_{10} - ± 20% σ_{0-1} - ± 25% σ_{1-1} = unreliable data.

Notes:

σ_{10} has not been measured between 200 keV and 1 MeV.



Graphical Data B-2.60.

Electron Capture Cross Sections for H^+ and H°

Passing Through Ne Gas

Tabular Data B-2.61.
Electron capture cross sections for H^+ and H° passing through Ar.

Energy (keV)	Cross Sections (cm^2)		
	σ_{10}	σ_{1-1}	σ_{0-1}
	$H^+ + Ar \rightarrow H^\circ$	$H^+ + Ar \rightarrow H^-$	$H^\circ + Ar \rightarrow H^-$
7.0 E-02	3.2 E-17		
1.0 E-01	5.8 E-17		
2.0 E-01	1.6 E-16		
4.0 E-01	4.0 E-16		
7.0 E-01	7.2 E-16		
1.0 E 00	9.3 E-16		
2.0 E 00	1.3 E-15	8.7 E-19	4.4 E-17
4.0 E 00	1.5 E-15	2.2 E-18	3.6 E-17
7.0 E 00	1.4 E-15	2.3 E-18	2.7 E-17
1.0 E 01	1.2 E-15	1.9 E-18	2.2 E-17
2.0 E 01	8.2 E-16	4.2 E-18	1.2 E-17
4.0 E 01	4.6 E-16	3.2 E-18	6.0 E-18
7.0 E 01	2.3 E-16	6.0 E-18	2.5 E-18
1.0 E 02	1.1 E-16	1.1 E-19	1.3 E-18
2.0 E 02	8.8 E-18	1.5 E-21	2.5 E-19
4.0 E 02	6.3 E-19	5.0 E-23	4.6 E-20
7.0 E 02	1.9 E-19	6.4 E-24	8.4 E-21
1.0 E 03	8.0 E-20	1.7 E-24	6.0 E-21
2.0 E 03	1.1 E-20		
4.0 E 03	7.5 E-22		
7.0 E 03	7.9 E-23		
1.0 E 04	1.9 E-23		
2.0 E 04	1.2 E-24		
4.0 E 04	7.2 E-26		

References:

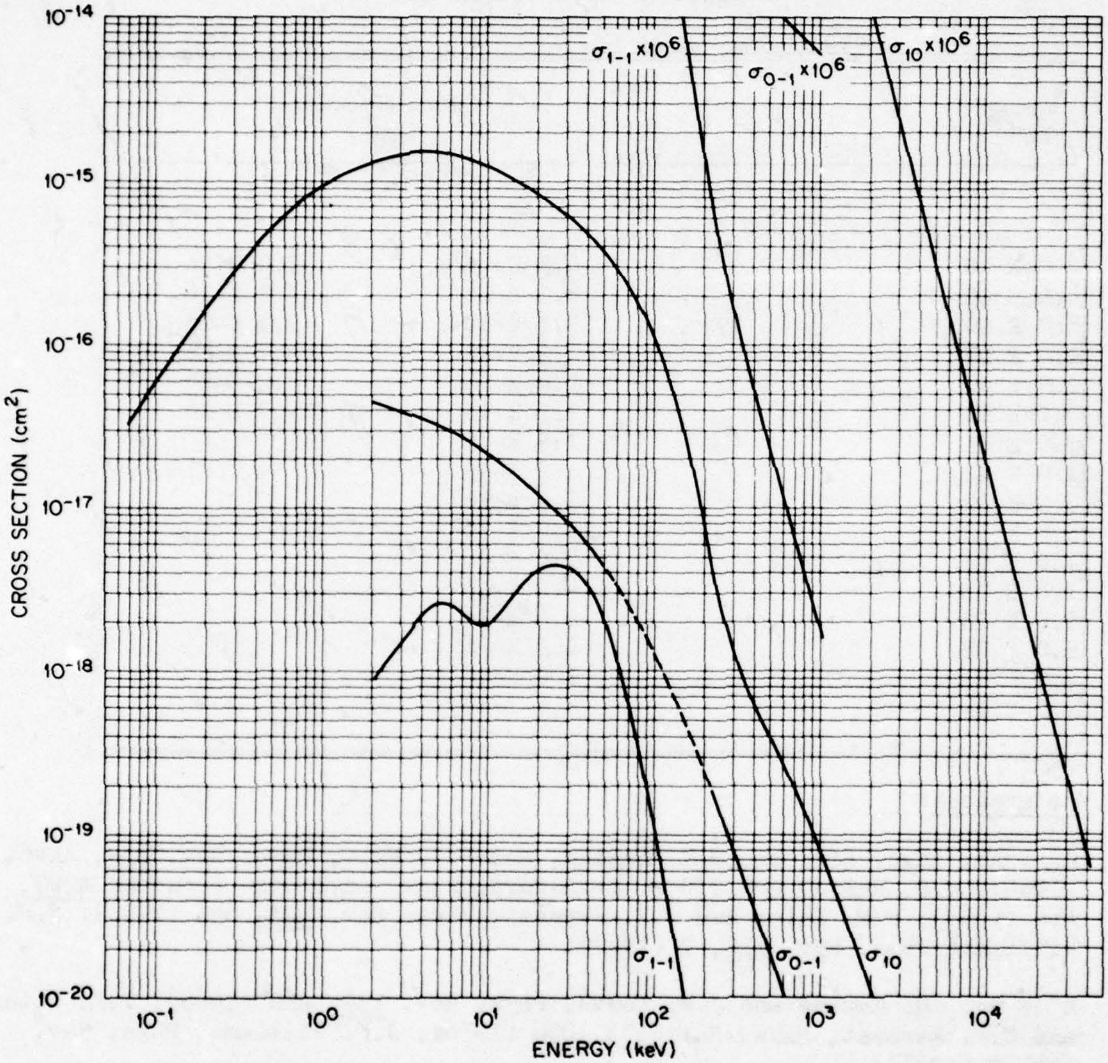
$H^+ + Ar \rightarrow H^\circ$: V. V. Afrosimov, Yu. A. Mamaev, M. N. Panov, V. Uroskevich, Sov. Phys.-Tech. Phys. 12, 512 (1967); V. V. Afrosimov, R. N. Iliǹ, E. S. Solovév, Sov. Phys.-Tech. Phys. 5, 661 (1960); E. Acerbi, M. Castiglioni, G. Dutto, F. Resmini, G. Succi, and G. Tagliaferri, Nuovo Cimento, 50B, 176 (1967); C. F. Barnett and H. K. Reynolds, Phys. Rev. 109, 355 (1958); K. H. Berkner, S. N. Kaplan, G. A. Paulikas, and R. V. Pyle, Phys. Rev. 140, A729 (1965); L. M. Welsh, K. H. Berkner, S. N. Kaplan, N. Selig, and R. V. Pyle, Phys. Rev. 158, 85 (1967); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956); Yu. S. Gordeev and M. N. Panov, Sov. Phys.-Tech. Phys. 9, 656 (1964); F. J. de Heer, J. Schutten, and H. Moustafa, Physica 32, 1766 (1966); D. W. Koopman, Phys. Rev. 154, 79 (1967); G. Monnom, Report EUR-CEA-FC-762 (1975); U. Schryber, Helv. Phys. Acta 40, 1023 (1967); L. H. Toburen, M. Y. Nakai, and R. A. Langley, Phys. Rev. 171, 114 (1968); J. F. Williams and D. N. F. Dunbar, Phys. Rev. 149, 62 (1966); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956).

$H^+ + Ar \rightarrow H^-$: V. V. Afrosimov, Yu. A. Mamaev, M. P. Panov, and V. Uroskevich, Sov. Phys.-Tech. Phys. 12, 512 (1967); Ya. M. Fogel, Sov. Phys.-Usp. 3, 390 (1960); V. V. Afrosimov, R. N. Il'in, and E. S. Solov'ev, Sov. Phys.-Tech. Phys. 5, 661 (1960); U. Schryber, Helv. Phys. Acta 40, 1023 (1967); L. H. Toburen, M. Y. Nakai, and R. A. Langley, Phys. Rev. 177, 191 (1969); J. F. Williams, Phys. Rev. 150, 7 (1966).

$H^\circ + Ar \rightarrow H^-$: T. M. Donahue and F. Hushfar, Phys. Rev. 124, 138 (1961); Ya. M. Fogel, V. A. Ankudinov, D. V. Phipenko, and N. V. Topolia, Sov. Phys.-JETP 7, 400 (1958); U. Schryber, Helv. Phys. Acta 40, 1023 (1967); P. M. Stier and C. F. Barnett, Phys. Rev. 103, 896 (1956); J. F. Williams, Phys. Rev. 153, 117 (1967).

Accuracy:

σ_{10} - ± 25% σ_{0-1} ± 40% σ_{1-1} ± 40%



Graphical Data B-2.62.

Electron Capture Cross Sections for H^+ and H°

Passing Through Ar

Tabular Data B-2.63.

Cross Sections for Single Electron Loss or

Stripping for H^- in Ar and Ne

Energy (keV)	Cross Sections (cm^2) Ar	Ne
2.0 E 00	6.5 E-16	3.0 E-16
4.0 E 00	8.3 E-16	3.3 E-16
6.0 E 00	9.7 E-16	3.5 E-16
1.0 E 01	1.2 E-15	3.7 E-16
2.0 E 01	1.6 E-15	4.2 E-16
5.0 E 01	1.5 E-15	4.9 E-16
7.0 E 01	1.3 E-15	
1.0 E 02	1.2 E-15	
2.0 E 02	9.0 E-16	
5.0 E 02	6.0 E-16	
7.0 E 02	5.0 E-16	
1.0 E 03	4.0 E-16	
2.0 E 03	2.6 E-16	
5.0 E 03	1.3 E-16	
7.0 E 03	1.0 E-16	
1.0 E 04	7.5 E-17	

References:

H^- + Ar: K.H. Berkner, S.N. Kaplan, and R.V. Pyle, Phys. Rev. 134, A1461 (1964); J.B. Hasted and J.B.H. Stedeford, Proc. Roy. Soc. (London) A227, 466 (1955); P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956); J.F. Williams, Phys. Rev. 154, 9 (1967).

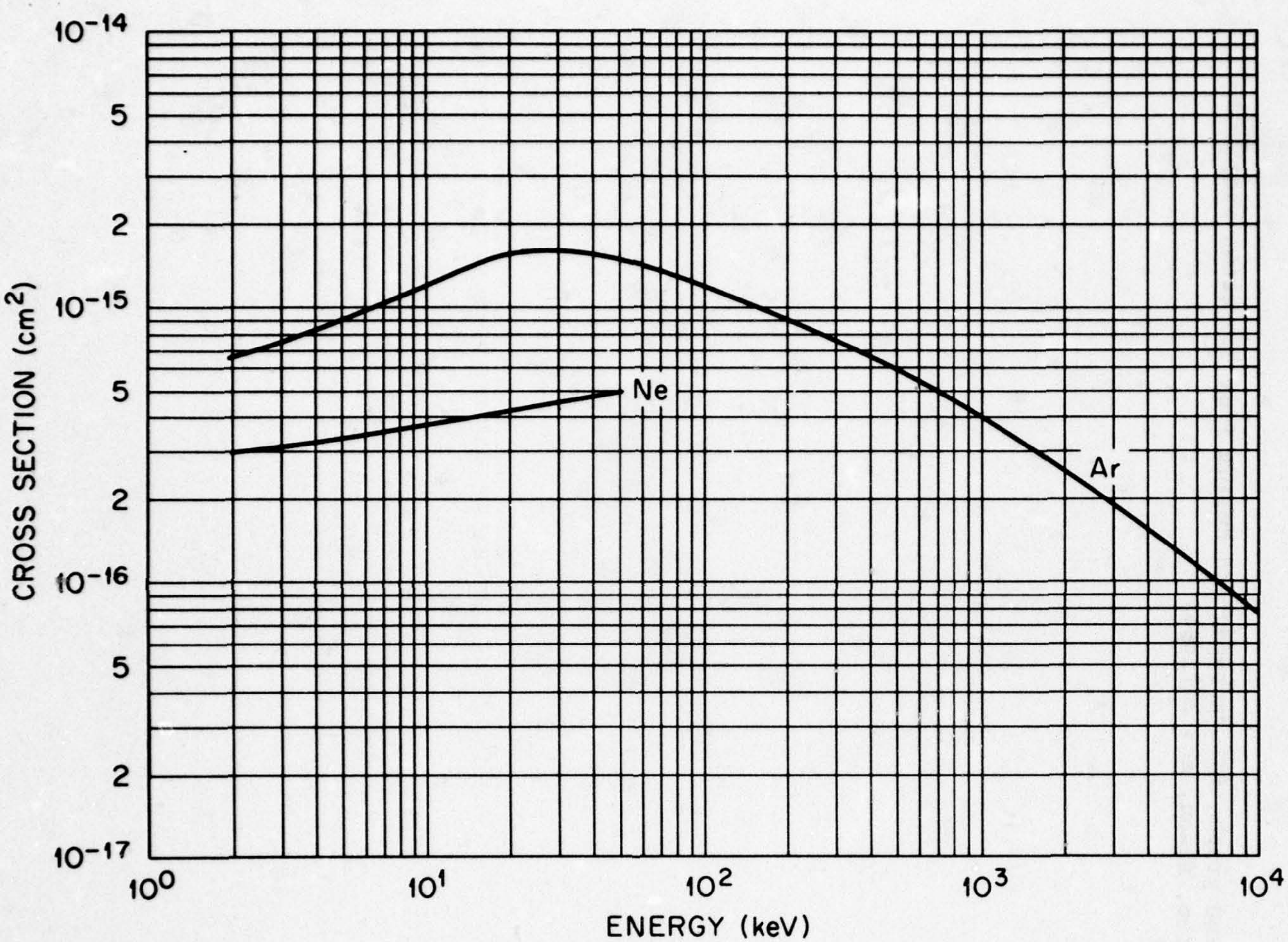
H^- + Ne: R. Smythe and J.W. Toevs, Phys. Rev. 139, A15 (1965); P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956); J.F. Williams, Phys. Rev. 154, 9 (1967).

Accuracy:

± 25%

Note:

Berkner, et al., result for H^- + Ar at 10 MeV were obtained from D^- + Ar at 20 MeV.

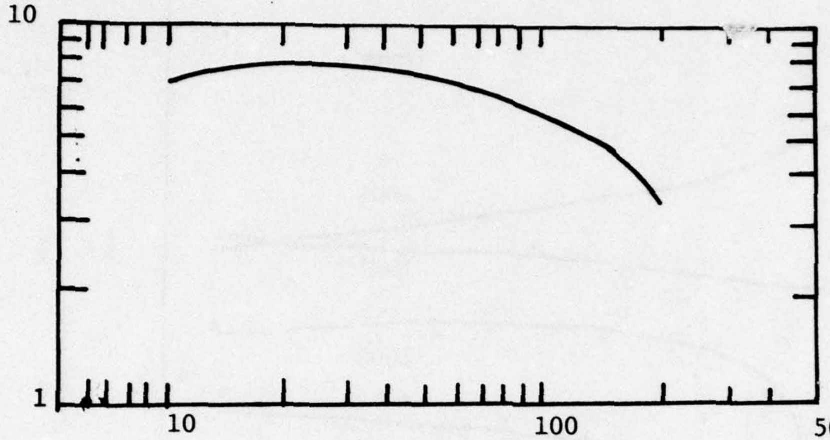


Graphical Data B-2.64.

Cross Sections for Single Electron Loss of He^- Ions in H_2 and He

H^n, He^m/Kr, Xe, Halides

Tables and graphs for hydrogen and helium ions and atoms incident on krypton, xenon, and halides.

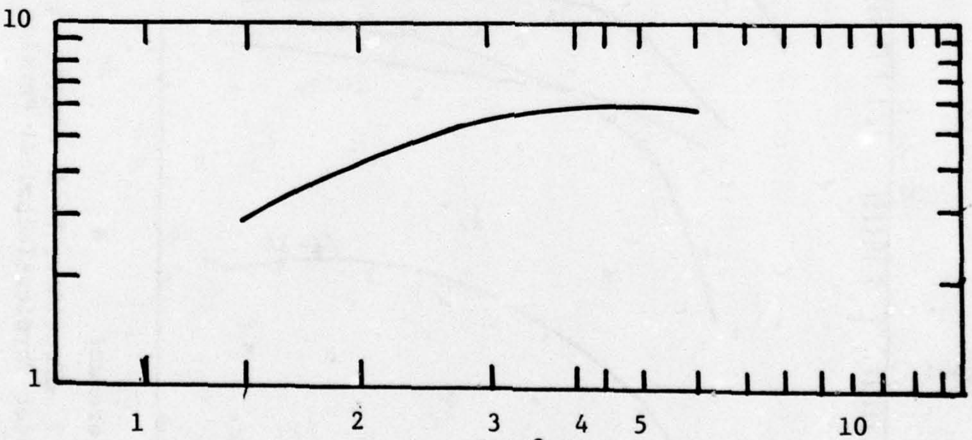


E(keV)

H+Kr → Kr ion production

Reference:

E. S. Solov'ev, R. N. Il'in, V. A. Oparin and N. V. Fedorenko, Soviet Physics JETP, 15, 459 (1962).



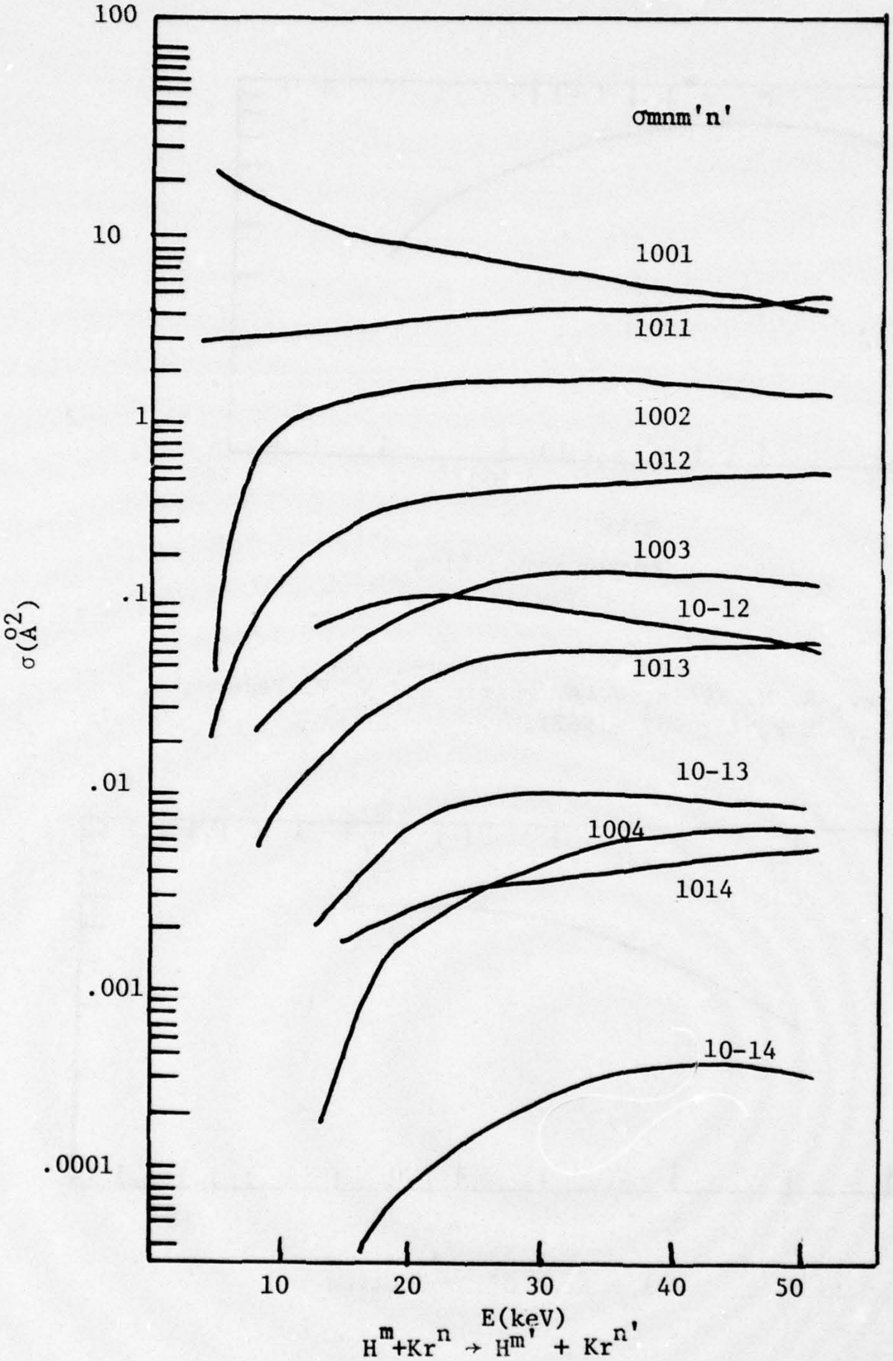
v(x10^{8}cm/s)

H + Kr → H^+ Production

Reference:

E. S. Solov'ev, R. N. Il'in, V. A. Oparin and N. V. Fedorenko, Soviet Physics JETP, 15, 459 (1962).

Graphical Data B-2.65.



$H^{m} + Kr^{n} \rightarrow H^{m'} + Kr^{n'}$

m,m'=initial, final charge on H

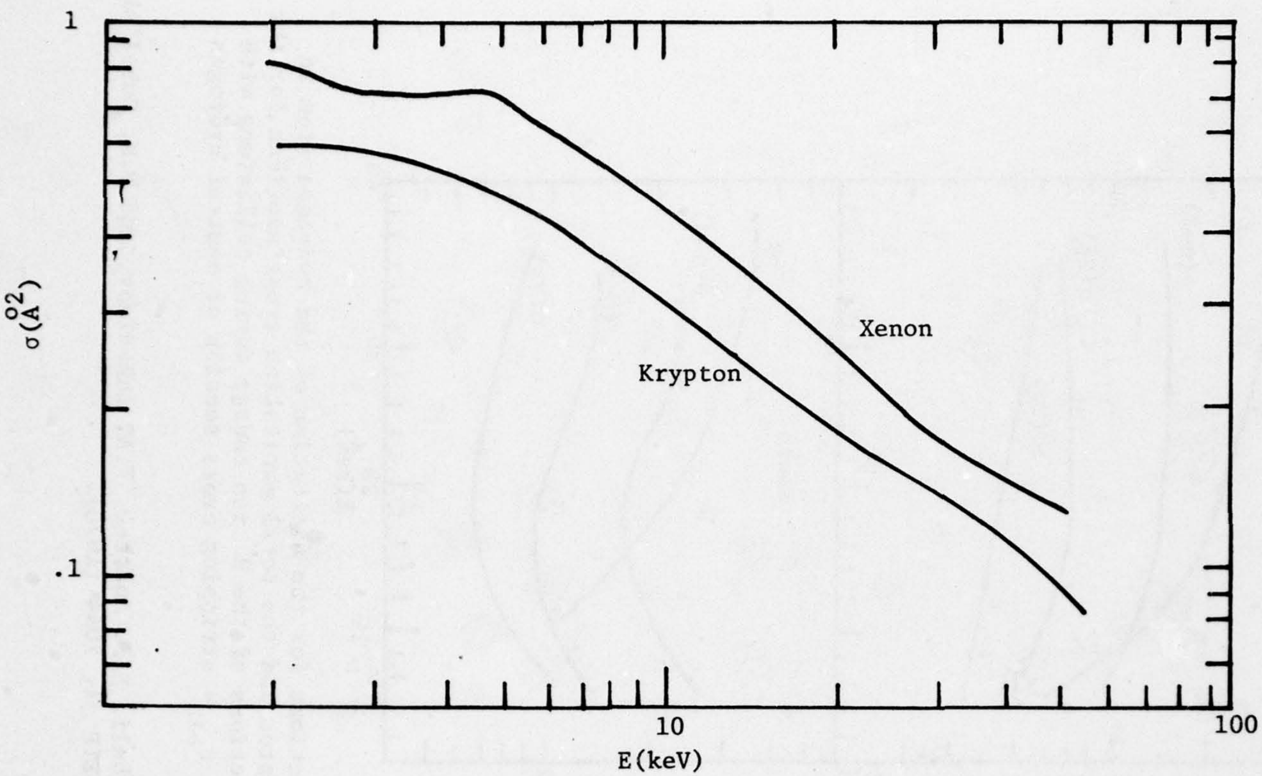
n,n'=initial, final charge on Kr

10-14 implies $H^{+} + Kr \rightarrow H^{-} + Kr^{4+}$

Graphical Data B-2.66.

Reference:

V. V. Afrosimov, Y. A. Manaev, M. N. Panov, and N. V. Fedorenko, Soviet Physics-Technical Physics 14, 109 (1969).

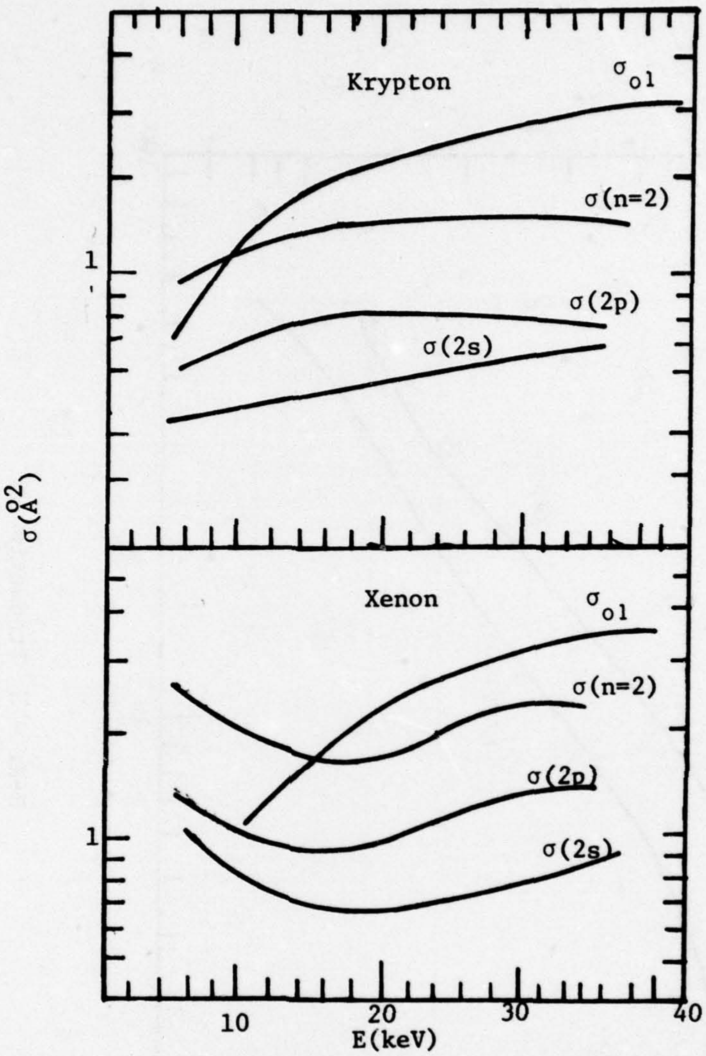


$H+Kr \rightarrow H^-$ Production

$H+Xe \rightarrow H^-$ Production

Ref. J.F. Williams, Phys. Rev. 153, 116 (1967).

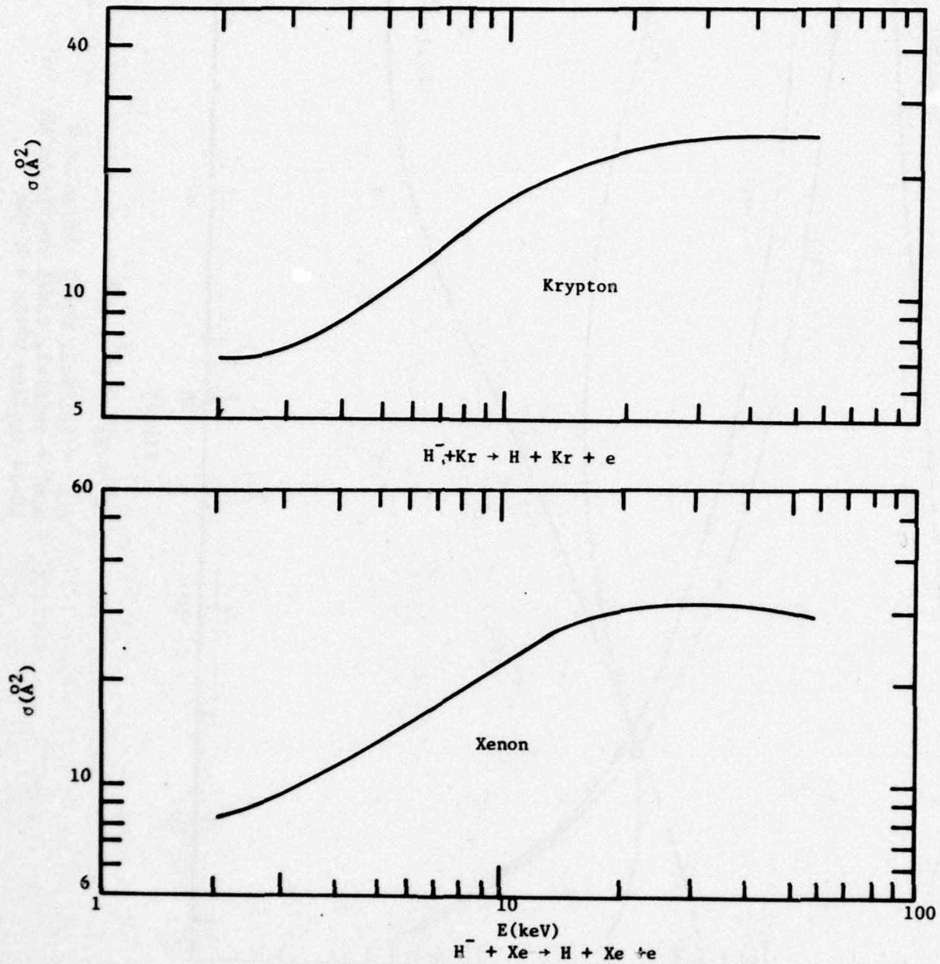
Graphical Data B-2.67.



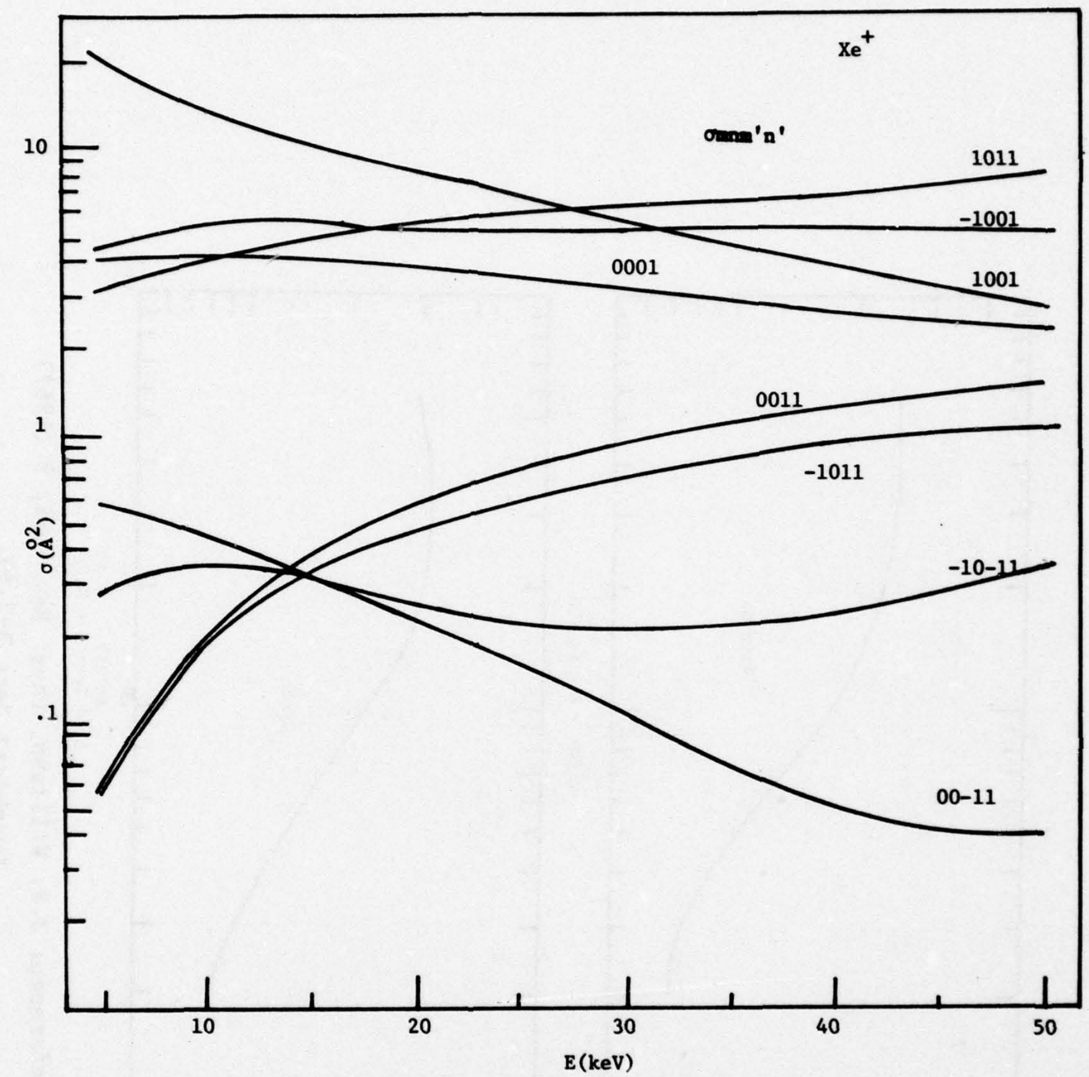
Cross sections for the excitation of the hydrogen atom in the 2s and 2p states and the total excitation cross sections for the n=2 state as functions of the H^- ion energy during collisions with inert gas atoms. σ_{o1} - stripping cross section of neutral hydrogen atoms.

Ref. A.L. Orbeli, E.P. Andreev, V.A. Ankudinov, and V.M. Dukel'skii Soviet Physics JETP 31, 1044 (1970).

Graphical Data B-2.68.



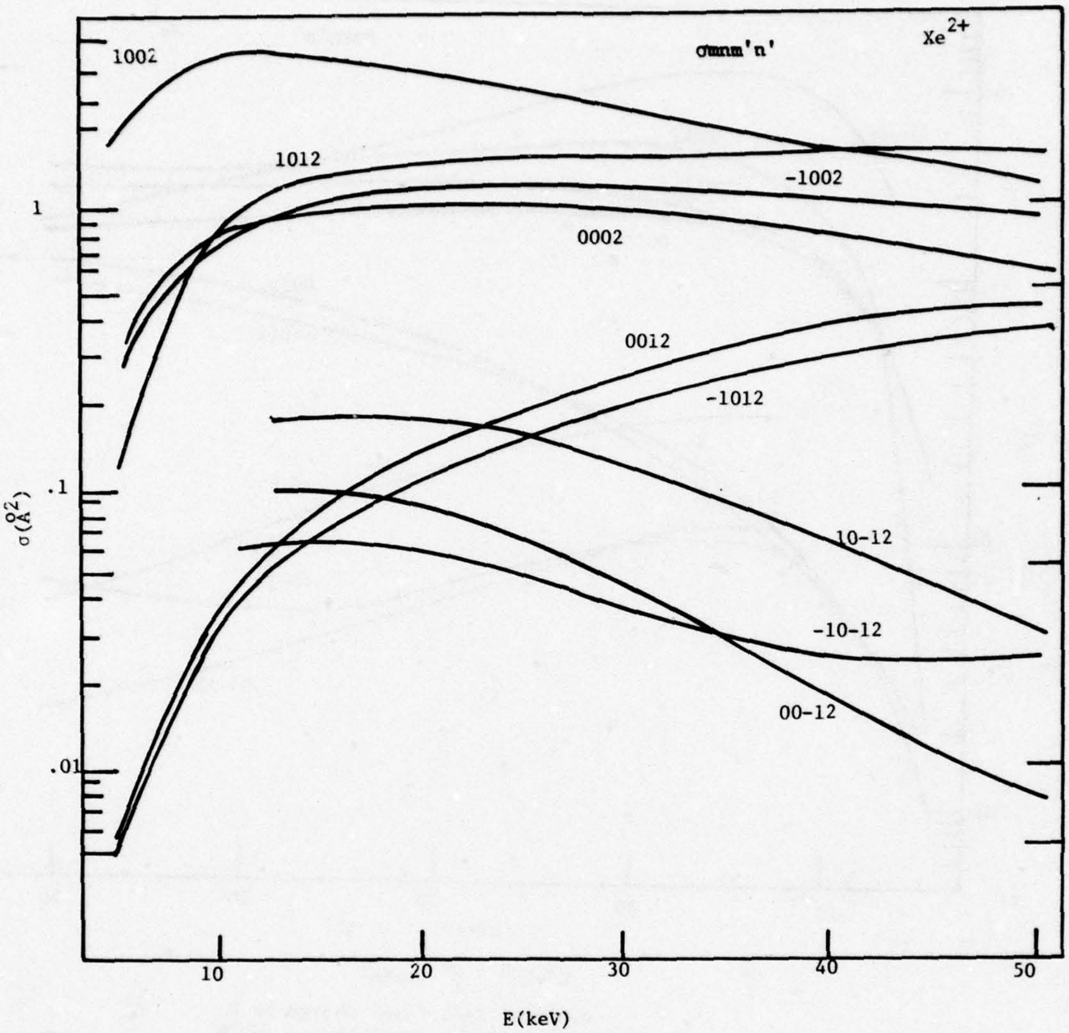
Reference: J.F. Williams, Phys. Rev. 154, 9 (1967).
Graphical Data B-2.69.



$H^m + Xe^n \rightarrow H^{m'} + Xe^{n'}$

m,m' = initial, final charge on H
n,n' = initial, final charge on Xe
10-14 implies $H^+ + Xe \rightarrow H^- + Xe^{4+}$

Reference: V.V. Afrosimov, Y.A. Mamaev, M.N. Panov and N.V. Fedorenko, Soviet Physics JETP 28, 52 (1969).
Graphical Data B-2.70.

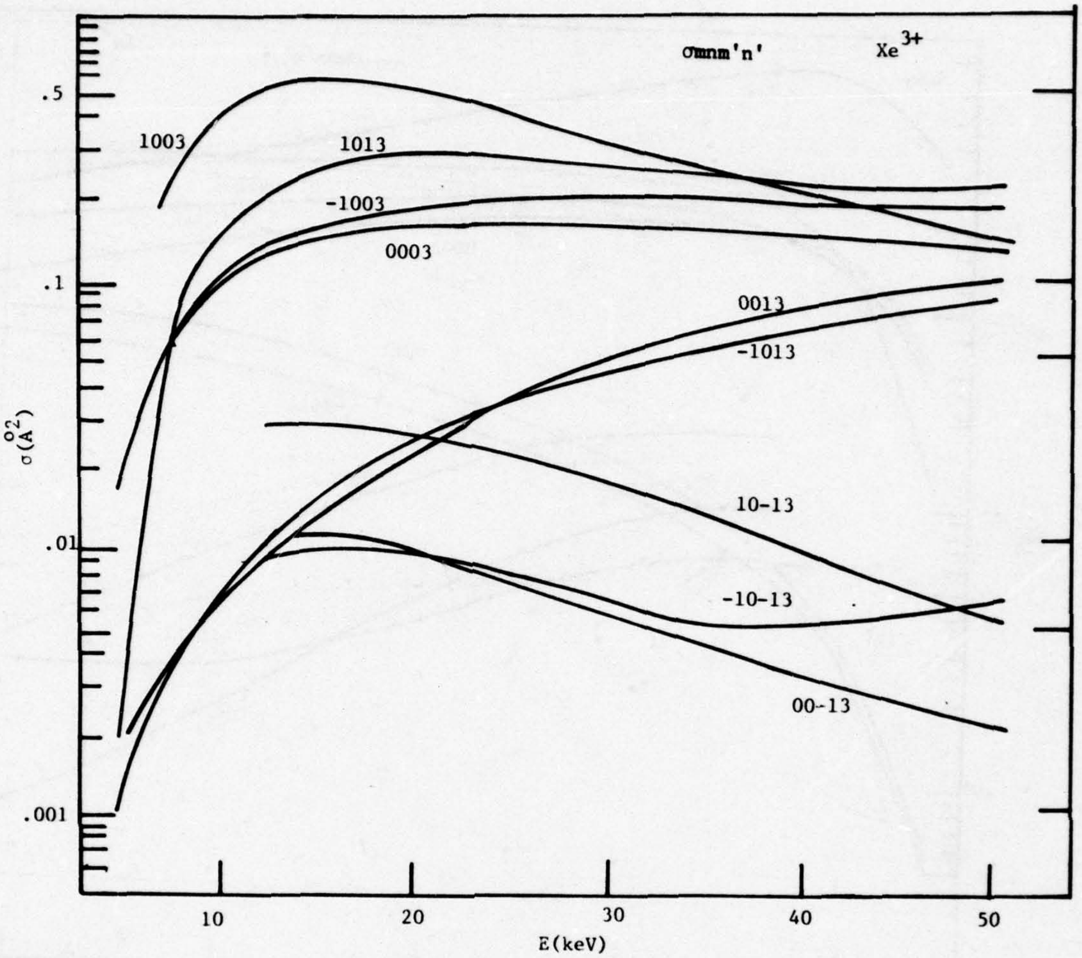


$H^m + Xe^n \rightarrow H^{m'} + Xe^{n'}$

m,m'=initial, final charge on H
n,n'=initial, final charge on Xe
10-14 implies $H^+ + Xe \rightarrow H^- + Xe^{4+}$

Reference: V.V. Afrosimov, Y.A. Mamaev, M.N. Panov and N.V. Fedorenko, Soviet Physics JETP 28, 52 (1969).

Graphical Data B-2.71.

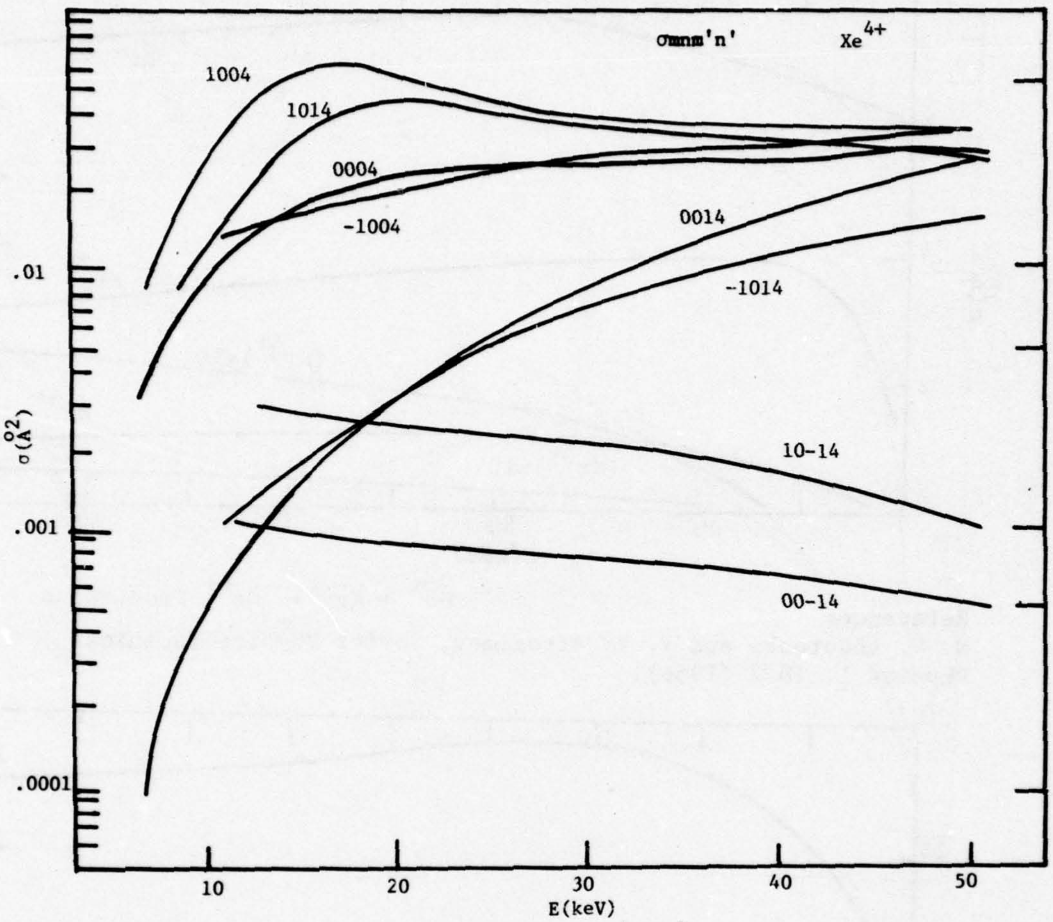


$H^m + Xe^n \rightarrow H^{m'} + Xe^{n'}$

m,m'=initial, final charge on H
n,n'=initial, final charge on Xe
10-14 implies $H^+ + Xe \rightarrow H^- + Xe^{4+}$

Reference: V.V. Afrosimov, Y.A. Mamaev, M.N. Panov and N.V. Fedorenko, Soviet Physics JETP 28, 52 (1969).

Graphical Data B-2.72.

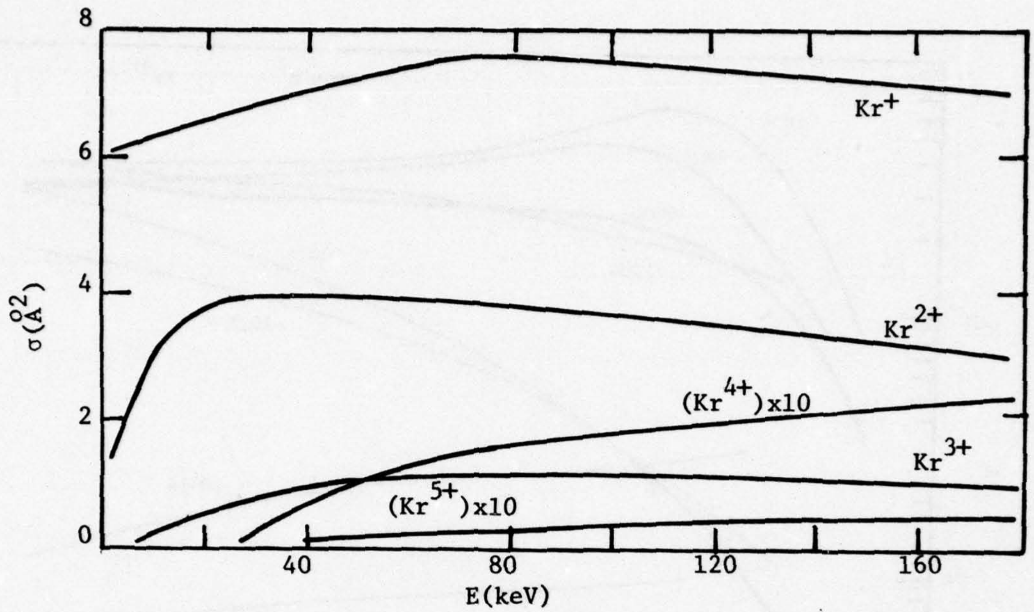


$H^{m}+Xe^{n} \rightarrow H^{m'}+Xe^{n'}$

m,m'=initial, final charge on H
n,n'=initial, final charge on Xe
10-14 implies $H^{+}+Xe \rightarrow H^{-}+Xe^{4+}$

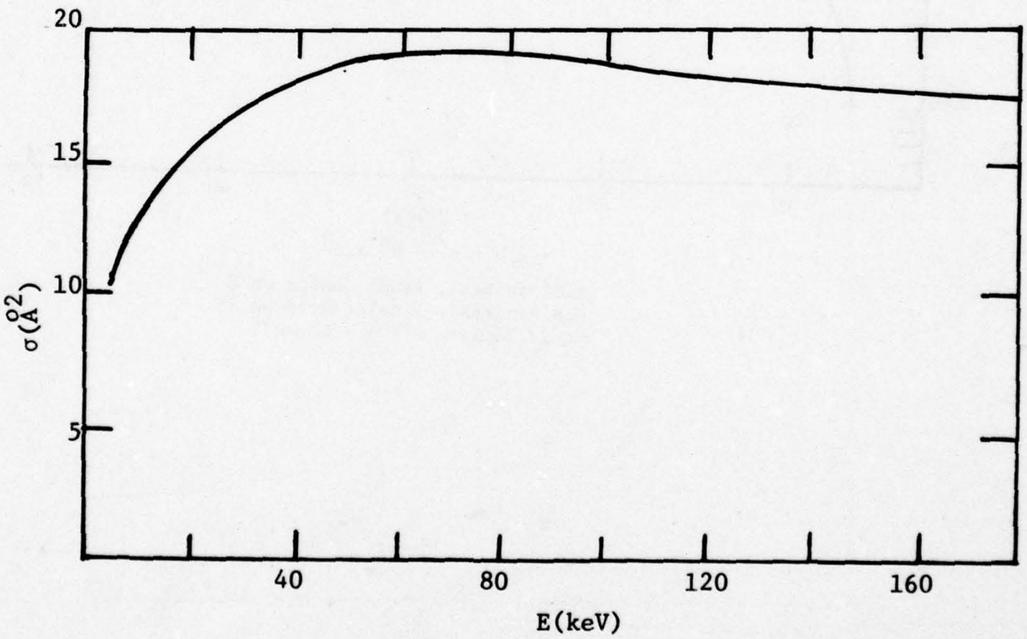
Reference: V.V. Afrosimov, Y.A. Mamaev, M.N. Panov and N.V. Fedorenko, Soviet Physics JETP <u>28</u>, 52 (1969).

Graphical Data B-2.73.



$He^+ + Kr \rightarrow Kr^{n+}$ Production

Reference:
N. V. Fedorenko and V. V. Afrosimov, Soviet Physics-Technical Physics 1, 1872 (1956).

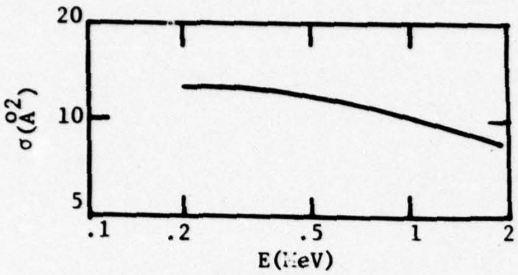


$He^+ + Kr \rightarrow$ slow ion production

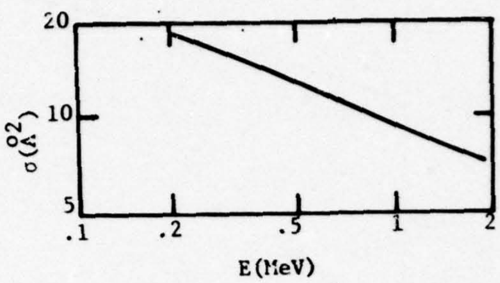
Reference:

N. V. Fedorenko, V. V. Afrosimov, and D. M. Kaminker, Soviet Physics-Technical Physics 1, 1861 (1956).

Graphical Data B-2.74.

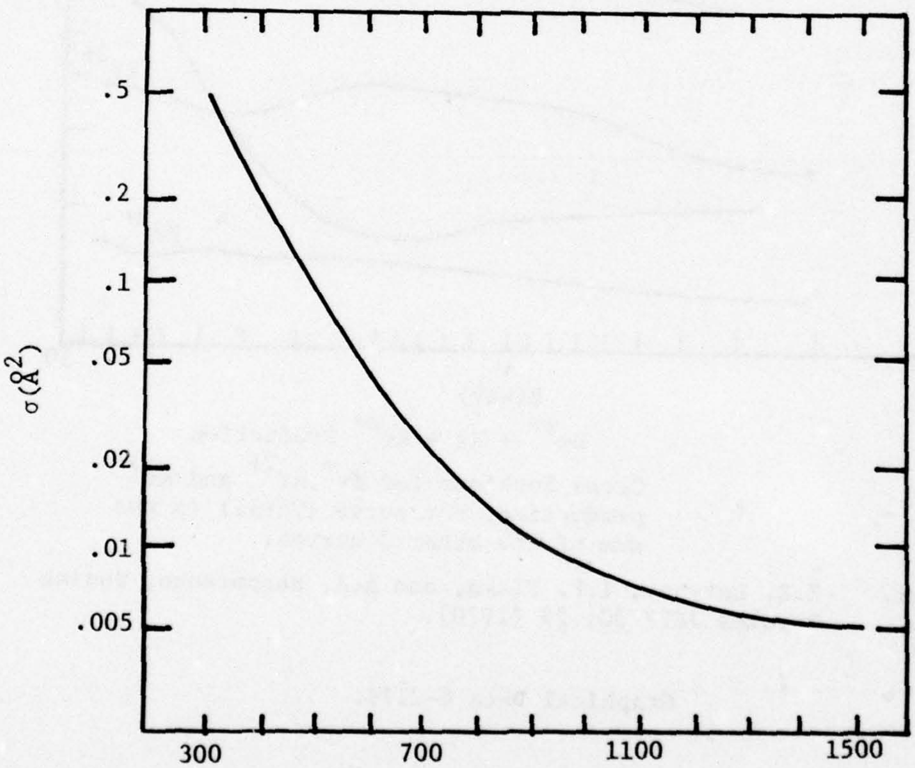


He^{+}+Kr → e Production



He^{+}+Kr → Kr^{+} Production

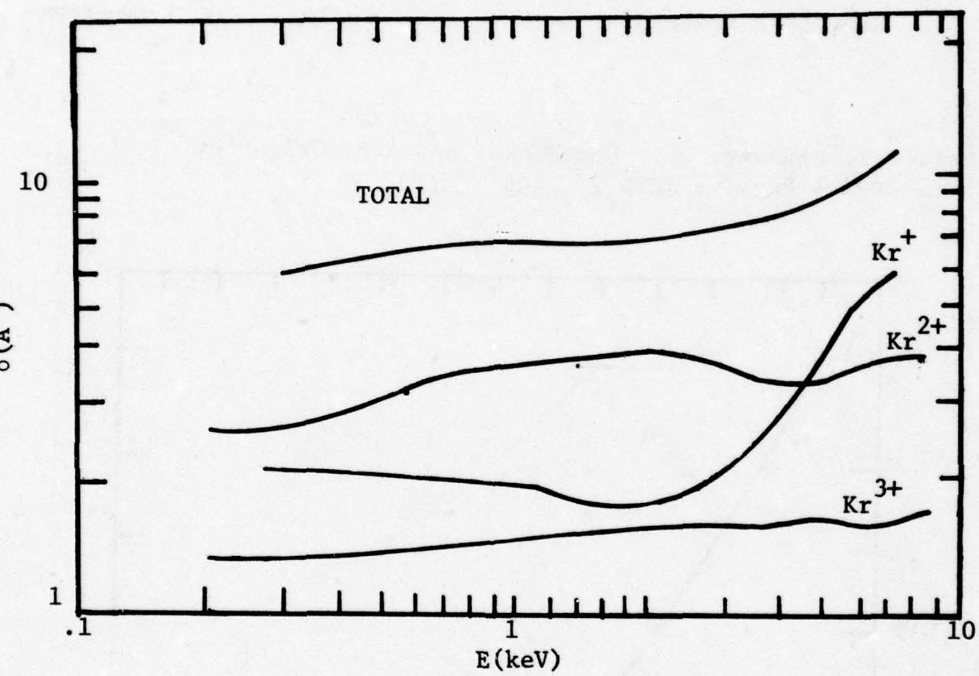
Ref. L.I. Pivovar, Y.Z. Levchenko, and A.N. Grigor'ev Soviet Physics JETP 27, 699 (1968).



He^{++} + Kr → He Production

Ref. L.I. Pivovar, M.T. Novikov, and V.M. Tubaev, Soviet Physics JETP 15, 1035 (1962).

Graphical Data B-2.75.

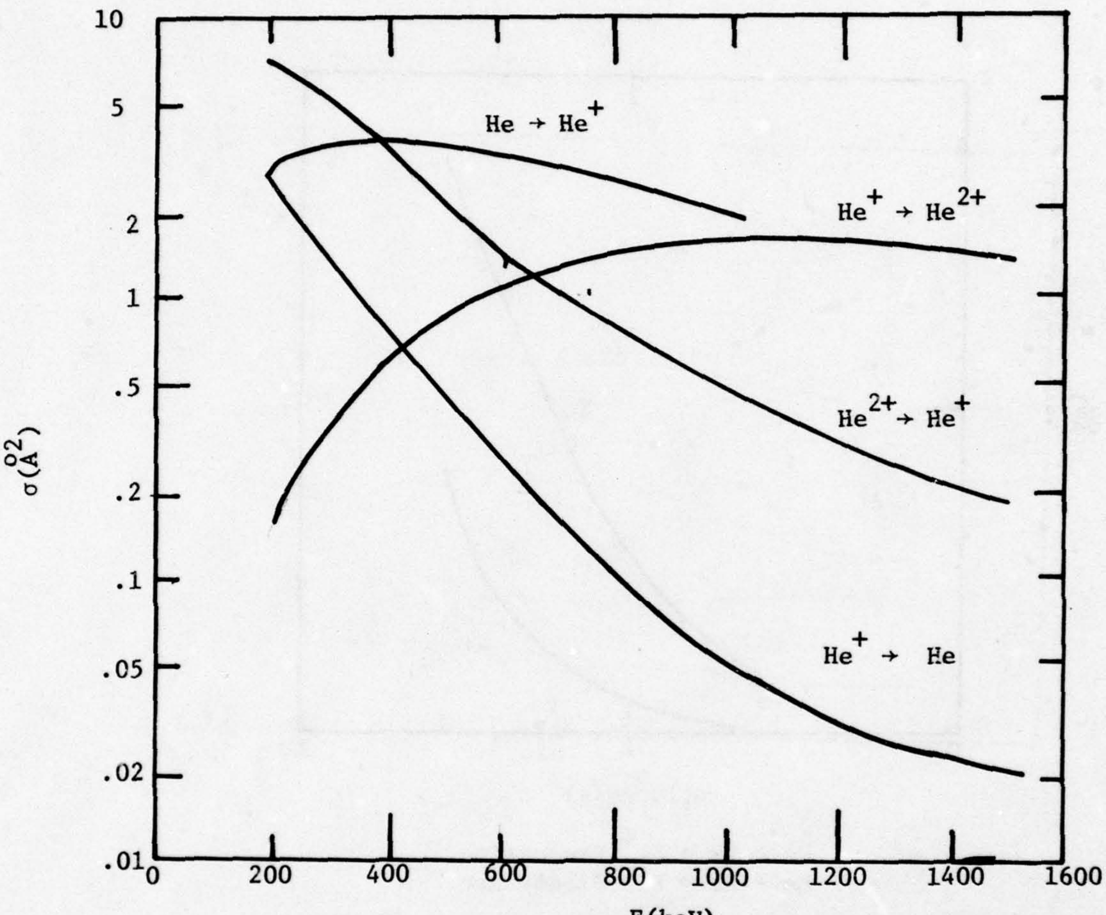


$He^{2+} + Kr \rightarrow Kr^{n+}$ Production

Cross Sections for Kr^+, Kr^{2+} and Kr^{3+} production. For curve (Total) is the sum of the other 3 curves.

Ref. Z.Z. Latypov, I.P. Flaks, and A.A. Shaporenko, Soviet Physics JETP 30, 29 (1970).

Graphical Data B-2.76.

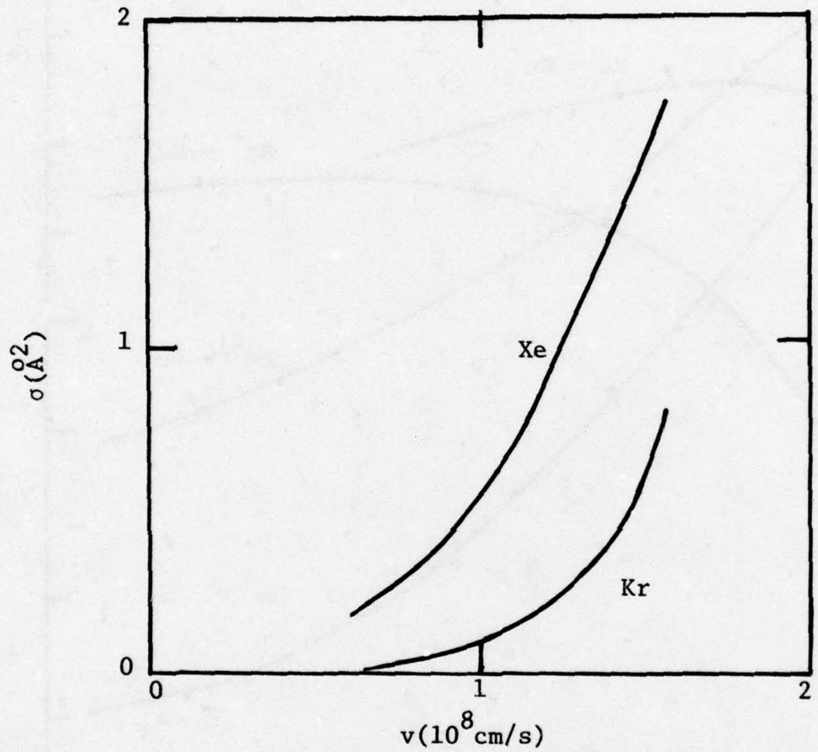


$He^{n+} + Kr \rightarrow He^{m+}$ Production
n=0,1,2 and m=0,1,2

Reference:

L. I. Pivovar, V. M. Tubaev, and M. T. Novikov, Soviet Physics JETP, 14, 20 (1962).

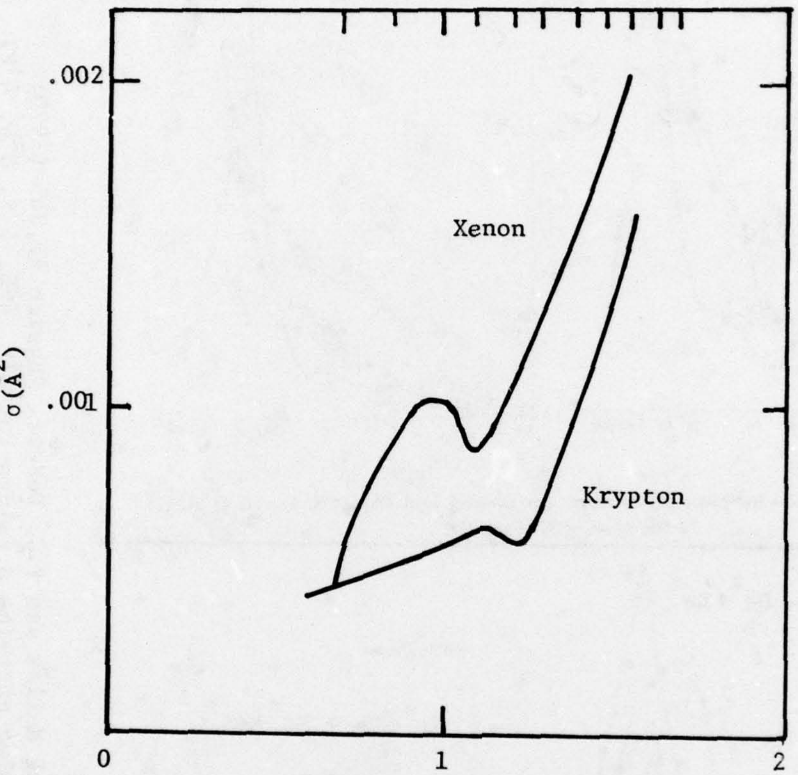
Graphical Data B-2.77.



$He + Kr \rightarrow He^+$ Production
$He + Xe \rightarrow He^+$ Production

Ref. Y.M. Fogel, V.A. Ankudinov, and D.V. Pilipenko, Soviet Physics JETP 11, 18 (1960).

Graphical Data B-2.78.

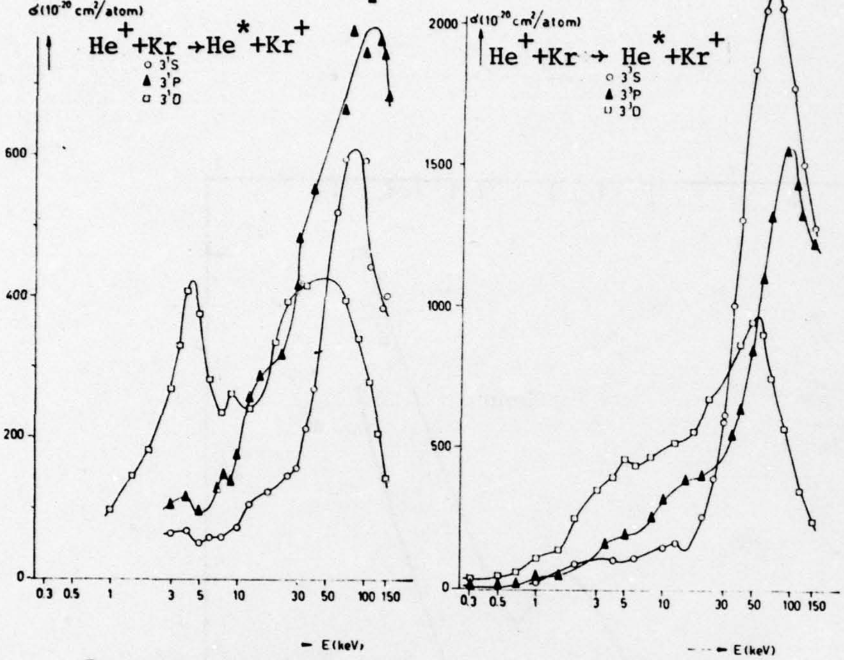


$v(10^8 cm/s$

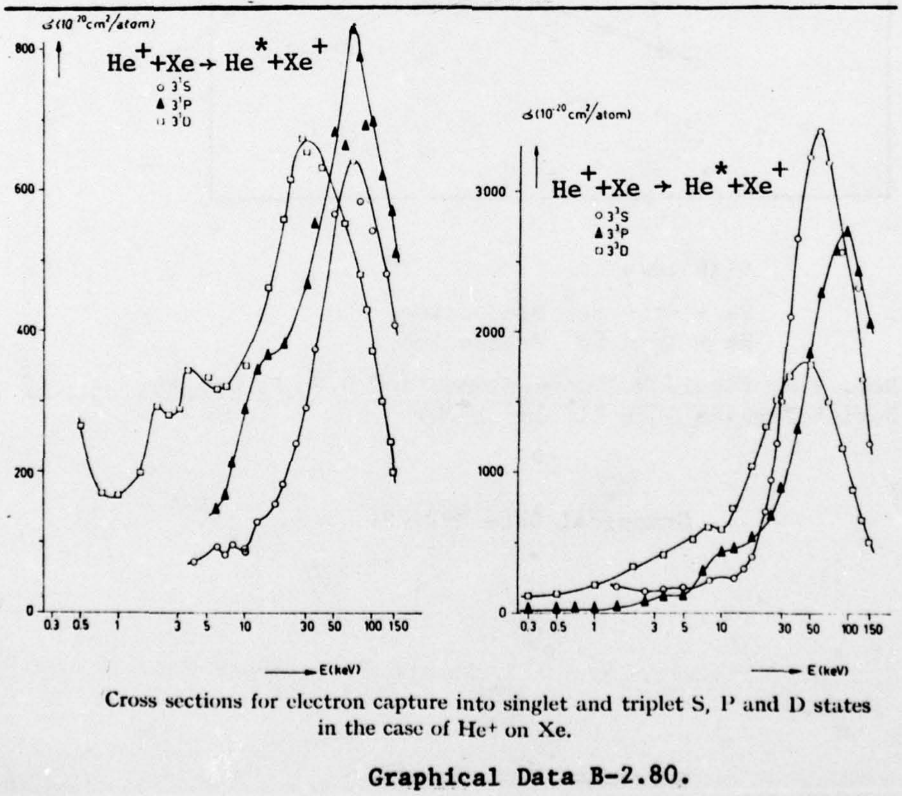
He + Kr → He^- Production
He + Xe → He^- Production

Ref. Y.M. Fogel, V.A. Ankudinov, and D.V. Pilipenko, Soviet Physics JETP 11, 18 (1960)

Graphical Data B-2.79.



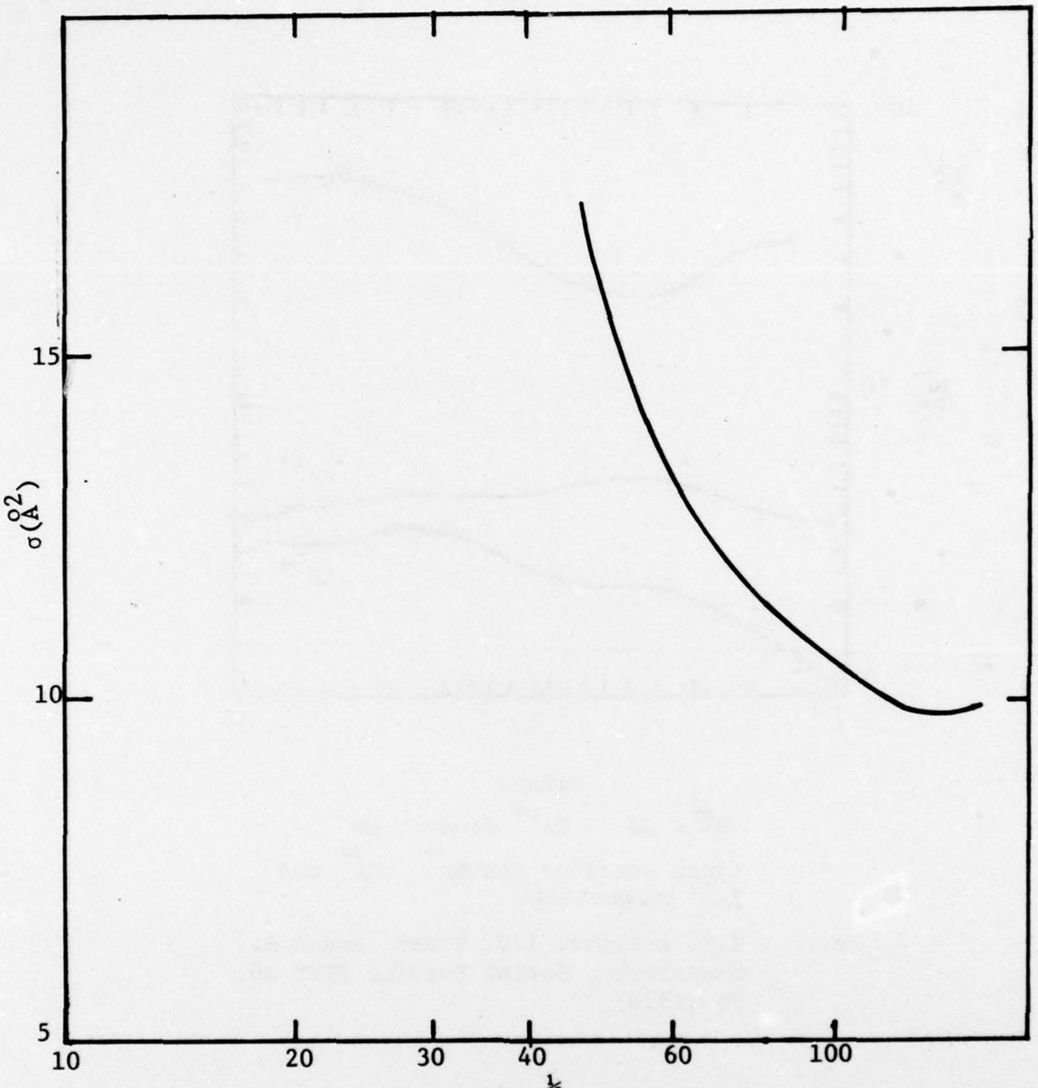
Cross sections for electron capture into singlet and triplet S, P and D states in the case of He^+ on Kr.



Cross sections for electron capture into singlet and triplet S, P and D states in the case of He^+ on Xe.

Graphical Data B-2.80.

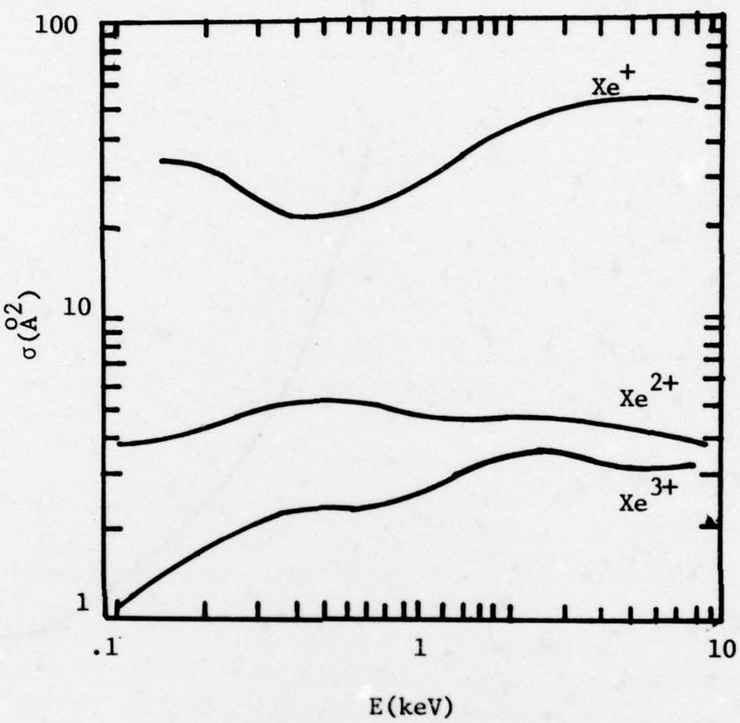
Ref. L. Wolterbeek Muller and F.J. DeHeer, Physica 48, 345 (1970)
(This reference also contains σ values for 4^1S, 4^3S, 5^1S, 5^3S, 4^1P, 4^3P, 5^3P, 4^1D, 4^3D, 5^1D, 5^3D, 6^3D production in collisions of He^+/He,Ne,Ar.Kr,Xe)



$He^+ + Xe \rightarrow He + Xe^+$

Reference: J.B.H. Stedeford and J.B. Hasted Proc. Royal Soc. (London) 227, 466 (1955).

Graphical Data B-2.81.

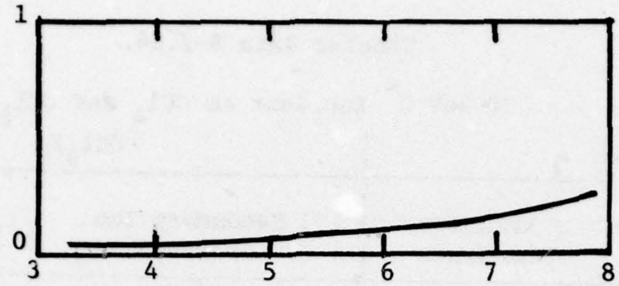


$He^{2+} + Xe \rightarrow Xe^{n+}$ Production

Cross sections for Xe^{+}, Xe^{2+} and Xe^{3+} production.

Ref. Z.Z. Latypov, I.P. Flaks, and A.A. Shaporenko, Soviet Physics JETP 30, 29 (1970).

Graphical Data B-2.82.



$F + He \rightarrow F^-$ Production

Ref. Y.M. Fogel, V.A. Ankudinov, and D.V. Pilipenko, Soviet Physics JETP 11, 18 (1960)

Graphical Data

Tabular Data

$H^m + CCl_2F_2 \rightarrow H^n$ production

E(MeV)	$\sigma(\mathring{A}^2)$	Reaction
.9	13.0 ± 18%	
1.1	11.3 ± 18%	$H^- + CCl_2F_2 \rightarrow H$
1.3	8.25 ± 18%	
.9	.73 ± 23%	
1.1	.6 ± 23%	$H^- + CCl_2F_2 \rightarrow H^+$
1.3	.5 ± 23%	
.9	6.0 ± 30%	
1.1	5.2 ± 30%	$H + CCl_2F_2 \rightarrow H^+$
1.3	3.8 ± 30%	

Ref. G.I. Dimov and V.G. Dudnikov, Soviet Physics-Technical Physics 11, 919 (1967).

Tabular and Graphical Data B-2.83.

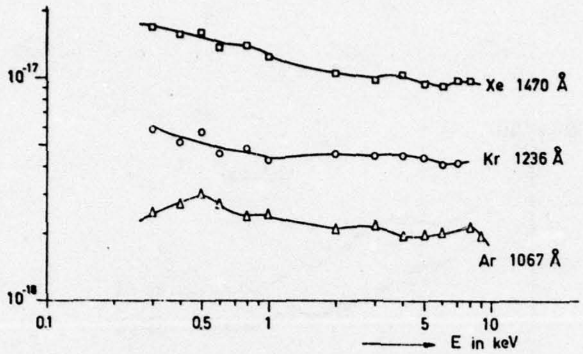
Tabular Data B-2.84.

30 keV H^- incident on CCl_4 and CCl_2F_2

CCl_4 Secondary Ion Produced	CCl_4 Relative Abundance	CCl_2F_2 Secondary Ion Produced	CCl_2F_2 Relative Abundance
Cl^{++}	0.34	C^{++}	-
Cl^+	28	F^{++}	-
CCl_2^{++}	-	C^+	4.05
CCl_2^+	12.5	F^+	4.18
CCl^+	15	CCl^{++}	0.7
CCl_3^{++}	-	CF^+	17.2
Cl_2^+	1.26	Cl^+	18.35
CCl_3^+	38	$CCl_2F_2^{++}$	-
CCl_4^+	0.09	$CCl^+ + CF_2^+$	40.5
C^+	3.8	CCl^+	-
C^-	0.28	CF_2^+	-
Cl^-	99.3	CCl_2F^{++}	-
CCl^-	0.18	$CClF^+$	12.3
Cl_2^-	0.24	CCl_2F^+	-
CCl_2^-	-	$CClF_2^+$	2.8
		F_2^+	-
		Cl_2^+	-
		$CCl_2F_2^+$	-
		C^-	4.1
		F^-	74.6
		Cl^-	21.3

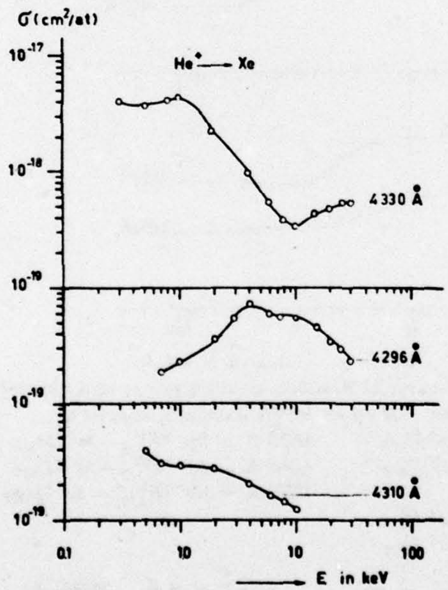
$\sigma \sim 3\times10^{-17} cm^2$ for 30keV H^- + CCl → slow negative ion production

Ref. Fogel, Koval, and Levchenko. Soviet Physics JETP 13 8 (1961)



Apparent emission cross sections of atomic resonance lines produced by He^+ incident on Ne, Ar, Kr and Xe at 10^{-3} torr.

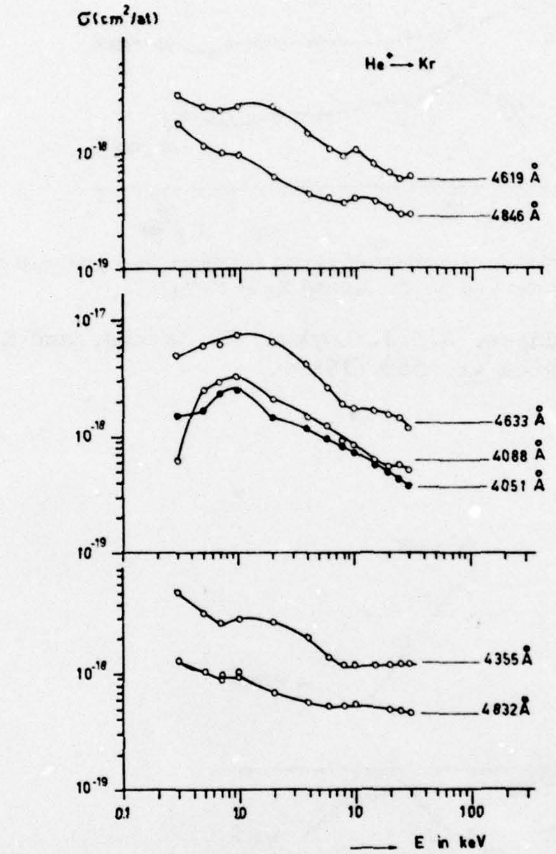
Ref. F.J. DeHeer, B.F.J. Luyken, D. Jaecks, and L. Wolterbeek Muller, Physica 41, 588 (1969).



Emission cross sections for $6d\ ^4F_{7/2}-6p\ ^4D^0_{5/2}$ ($\lambda = 4330$ Å), $7s\ ^4P_{1/2}-6p\ ^4P^0_{3/2}$ ($\lambda = 4296$ Å) and $7s'\ ^2D_{5/2}-6p\ ^2D^0_{3/2}$ ($\lambda = 4310$ Å) in the case of He^+ incident on Xe.

Ref. D. Jaecks, F.J. DeHeer, and A. Salop, Physica 36, 606 (1967).

Graphical Data B-2.85.



Emission cross sections for Kr II doublet, doublet prime and quartet lines by He^+ incident on Kr. All upper levels have a $5p$ electron.

4619 Å = $5p\ ^2P^0_{5/2} - 5s^2\ P_{3/2}$

4846 Å = $5p\ ^2P^0_{1/2} - 5s^2\ P_{3/2}$

4633 Å = $5p'\ ^2F^0_{5/2} - 5s'\ ^2D_{3/2}$

4088 Å = $5p'\ ^2D^0_{5/2} - 5s'\ ^2D_{5/2}$

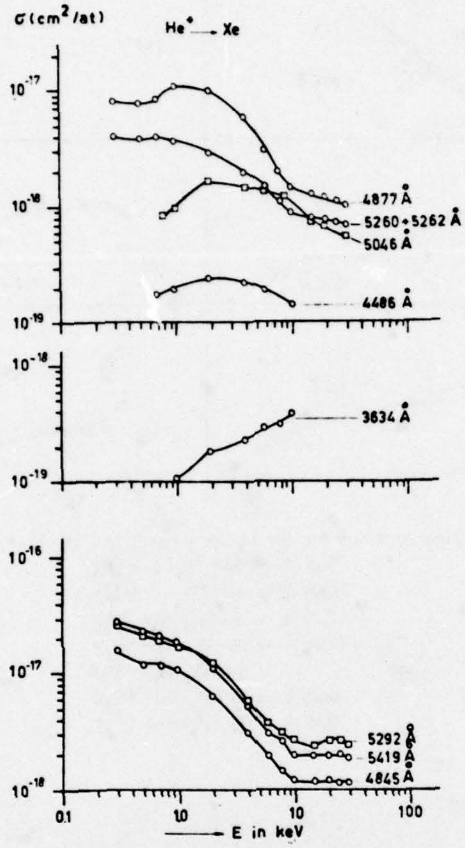
4057 Å = $5p'\ ^2P^0_{1/2} - 5s'\ ^2D_{3/2}$

4355 Å = $5p\ ^4D^0_{7/2} - 5s^4\ P_{5/2}$

4832 Å = $5p\ ^4P^0_{1/2} - 5s^4\ P_{3/2}$

Ref. D. Jaecks, F.J. DeHeer and A. Salop, Physica <u>36</u>, 606 (1967).

Graphical Data B-2.86.

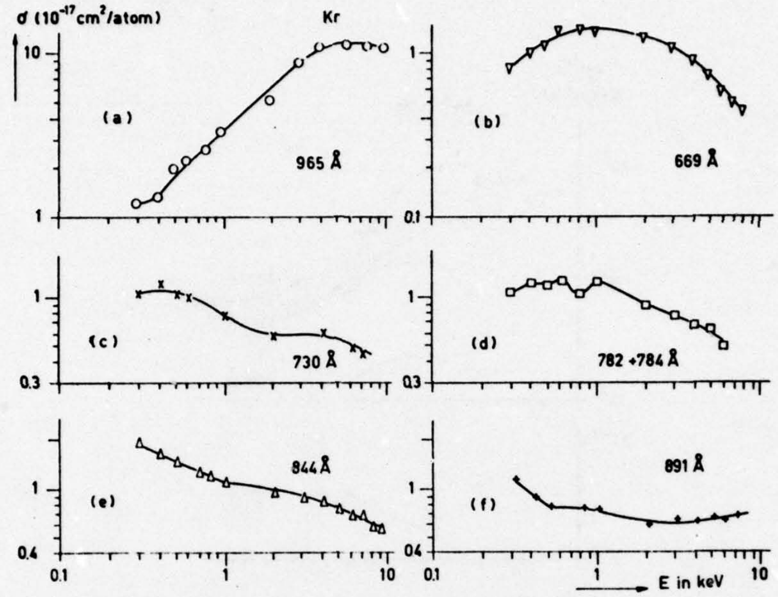


Emission cross sections for Xe II doublet prime, doublet double prime and quartet lines produced by He^+ incident on Xe. All upper levels have a $6p$ electron

4877 Å $= 6p'\ ^2F^0_{7/2} - 6s'\ ^2D_{5/2}$	3634 Å $= 6p''\ ^2P^0_{3/2} - 5d'\ ^2D_{5/2}$
5046 Å $= 6p'\ ^2P^0_{1/2} - 6s'\ ^2D_{3/2}$	
4486 Å $= 6p'\ ^2P^0_{3/2} - 5d\ ^4P_{3/2}$	5292 Å $= 6p\ ^4P^0_{5/2} - 6s\ ^4P_{5/2}$
5262 Å $= 6p'\ ^2D^0_{3/2} - 6s'\ ^2D_{3/2}$	5419 Å $= 6p\ ^4D^0_{5/2} - 6s\ ^4P_{3/2}$
5260 Å $= 6p\ ^2P^0_{3/2} - 6s\ ^2P_{1/2}$	4845 Å $= 6p\ ^4D^0_{7/2} - 6s\ ^4P_{5/2}$

Ref. D. Jaecks, F.J. DeHeer and A. Salop, Physica <u>36</u>, 606 (1967).

Graphical Data B-2.87.



Emission cross sections for Kr II lines produced by He^+ incident on Kr.

965 Å = $4p^6\ {}^2S_{1/2}$–$4p^5\ {}^2P_{1/2}{}^0$

669 Å = $4d'\ {}^2D_{3/2}$–$4p^5\ 2P_{1/2}{}^0$

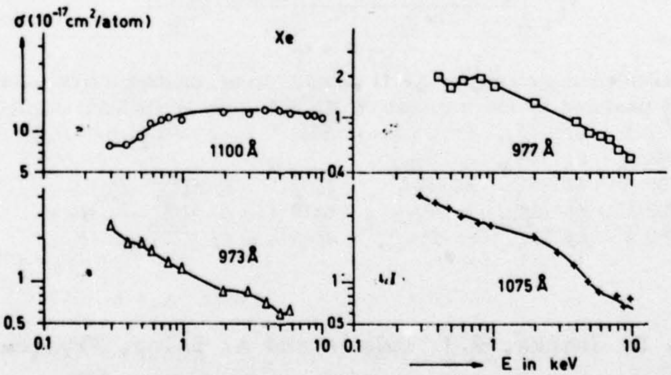
730 Å = $4d\ {}^2F_{5/2}$–$4p^5\ {}^2P_{3/2}{}^0$

. 782 + 784 Å = $5s'\ {}^2D$–$4p^5\ {}^2P_{1/2}{}^0$

+ $4d\ {}^2D_{3/2}$–$4p^5\ {}^2P_{3/2}{}^0$

844 Å = $5s\ {}^2P_{1/2}$–$4p^5\ {}^2P_{1/2}{}^0$

891 Å = $5s\ {}^4P_{1/2}$–$4p^5\ {}^2P_{3/2}{}^0$



Emission cross sections for Xe II lines produced by He^+ incident on Xe.

1100 Å = $5p^6\ {}^2S_{1/2}$–$5p^5\ {}^2P_{1/2}{}^0$

977 Å = $6s'\ {}^2D_{3/2}$–$5p^5\ {}^2P_{1/2}{}^0$

973 Å = $6s\ {}^2P_{1/2}$–$5p^5\ {}^2P_{1/2}{}^0$

1075 Å = $6s\ {}^4P_{1/2}$–$5p^5\ {}^2P_{3/2}{}^0$

Ref. F.J. DeHeer, B.F.J. Luyken, D. Jaecks, and L. Wolterbe Muller Physica 41, 588 (1969).

Graphical Data B-2.88.

Tabular Data B-2.89.

EXCITATION OF Kr AND Xe BY He^+ IMPACT

Kr II emission cross sections in units 10^{-17} cm^2/atom 2 keV He^+ impact energy, compared to contribution from cascade

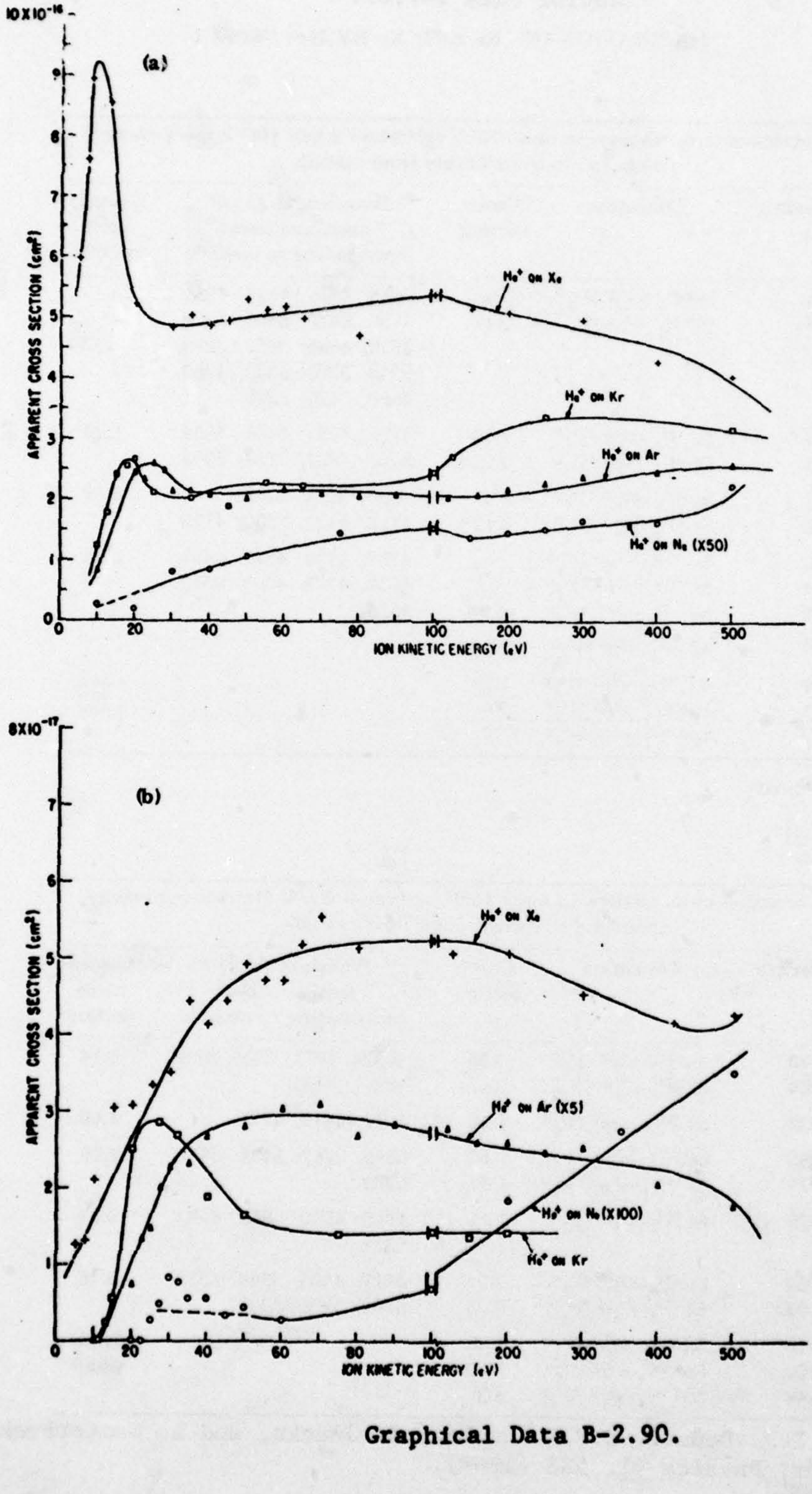
Wavelength (Å)	Transition	Cross section	Wavelength (Å) of measured lines contributing to cascade	Cascade cross section
844	$5s^2\ P_{1/2}-s^2p^5\ {}^2P_{3/2}$	0.96	4615, 4846, 4619, 4251,	
865	$5s^2\ P_{1/2}-s^2p^5\ {}^2P_{1/2}$	0.47	4185, 6472, 5683, 5024,	
			4610, 4825, 3151, 3275,	1.02
			5218, 3200, 5523, 4762,	
			4680, 3420, 3205	
869	$5s\ {}^4P_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$	1.10	4766, 4293, 3988, 5309,	1.80
911	$5s\ {}^4P_{3/2}-s^2p^5\ {}^2P_{1/2}{}^0$	0.22*	5208, 4832, 3754, 3995	
891	$5s\ {}^4P_{1/2}-s^2p^5\ {}^2P_{1/2}{}^0$	0.57	4099, 4651, 4437,	0.32
850	$5s\ {}^4P_{1/2}-s^2p^5\ {}^2P_{3/2}{}^0$	0.12*	4812, 4432, 5500, 4145	
782	$5s'\ {}^2D_{5/2}-s^2p^5\ {}^2P_{3/2}{}^0$	0.90	4088, 4109, 4577, 4691,	2.36
784	$5s'\ {}^2D_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$		4057, 4422, 4065, 4045,	1.49
818	$5s'\ {}^2D_{3/2}-s^2p^5\ {}^2P_{1/2}{}^0$	small	4633	
730	$4d\ {}^2F_{5/2}-s^2p^5\ {}^2P_{3/2}{}^0$	0.55		
669	$4d'\ {}^2D_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$	1.16		small
965	$4p^6\ {}^2S_{1/2}-s^2p^5\ {}^2P_{1/2}{}^0$	5.0		small
917	$4p^6\ {}^2S_{1/2}-s^2p^5\ {}^2P_{3/2}{}^0$	3.9		

* estimated

Xe II emission cross sections in units 10^{-17} cm^2/atom 2 keV He^+ impact energy, compared to contribution from cascade

Wavelength	Transition	Cross section	Wavelength (Å) of measured lines contributing to cascade	Cascade cross section
973	$6s\ {}^2P_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$	0.85	5309, 3933, 3509, 4921,	0.74
1084	$6s\ {}^2P_{3/2}-s^2p^5\ {}^2P_{1/2}{}^0$	0.17	4887, 4920	
926	$6s'\ {}^2D_{5/2}-s^2p^5\ {}^2P_{3/2}{}^0$	1.40	4617, 4415, 4877	1.60
885	$6s'\ {}^2D_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$	0.50	5046, 5262, 5184, 5971	1.06
977	$6s'\ {}^2D_{3/2}-s^2p^5\ {}^2P_{1/2}{}^0$	1.27	6270	
1075	$6s\ {}^4P_{5/2}-s^2p^5\ {}^2P_{3/2}{}^0$	2.11	4845, 4890, 4216, 5293 5339	2.77
1052	$6s\ {}^4P_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$	2.0	5419, 4603, 3944, 5372	2.18
1183	$6s\ {}^4P_{3/2}-s^2p^5\ {}^2P_{1/2}{}^0$	0.25	3762, 5976, 5372	
912	$5d\ {}^2D_{3/2}-s^2p^5\ {}^2P_{3/2}{}^0$	1.40		small
1100	$5p^6\ {}^2S_{1/2}-s^2p^5\ {}^2P_{3/2}{}^0$	28.0		small
1244	$5p^6\ {}^2S_{1/2}-s^2p^5\ {}^2P_{1/2}{}^0$	6.3		

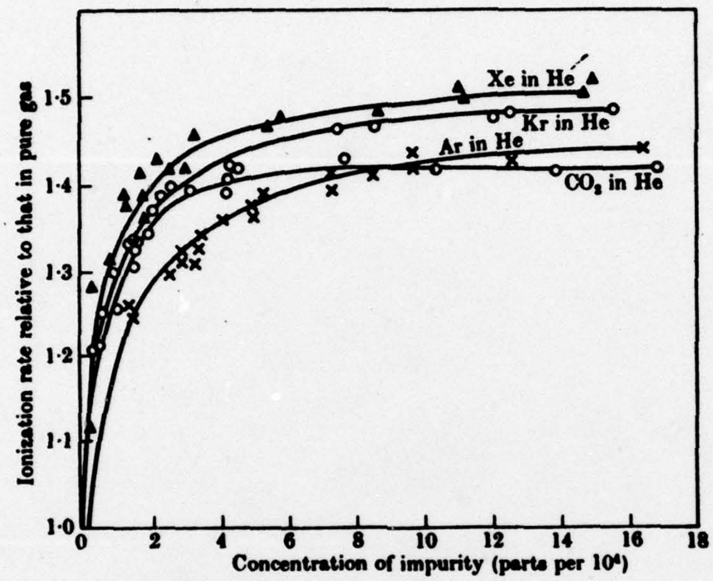
Ref. F.J. DeHeer, B.F.J. Luyken, D. Jaecks, and L. Wolterbeek Muller, Physica 41, 588 (1969).



(a) Kinetic-energy dependence of the cross sections for the production of photons by He^+ impact on the rare gases in the wavelength range from about 200 to 1200 Å. Note that the cross section for neon has been multiplied by a factor of 50. (b) Kinetic-energy dependence of the cross sections for the production of photons by He^+ impact on the rare gases in the wavelength range 1050 to 3500 Å. Note that the cross sections for argon and neon are multiplied by factors of 5 and 100, respectively.

Ref. M. Lipeles, R. Novick, and N. Tolk, Phys. Rev. Lett. 15, 815 (1965).

Graphical Data B-2.90.



Variation of the ionization rate for alpha particles in helium with concentration of added impurity.

(Alpha particles from polonium source)

Ref. H.S.W. Massey, E.H.S. Burhop and H.B. Gilbody, Electronic and Ionic Impact Phenomena, Vol. III, Second Edition, P. 1812 (Oxford University Press, 1971).

Graphical Data B-2.91.